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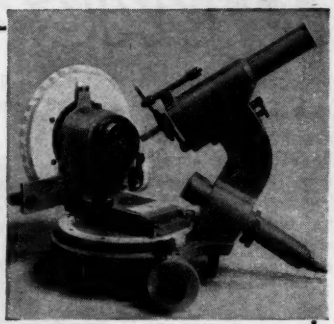

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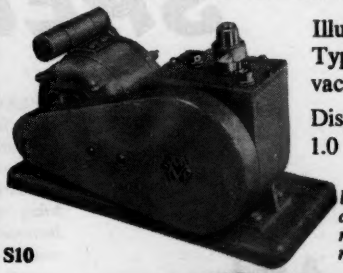

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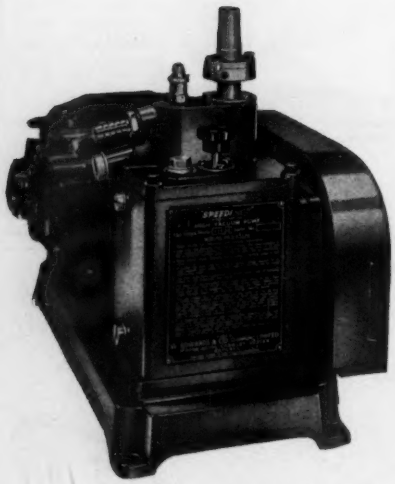

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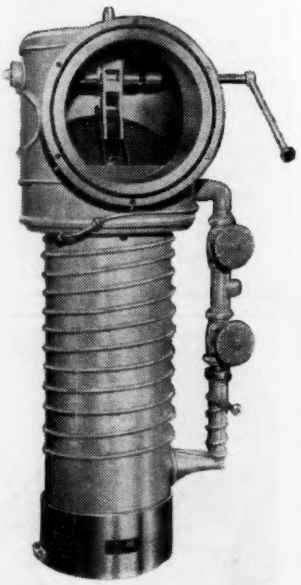

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INDUSTRIAL RELATIONS

IN a debate in the House of Commons a year ago on labour relations, Mr. A. E. Cooper, urging the value of an all-party approach to the problem, suggested the appointment of a Select Committee to inquire into the whole question of labour relations and the way in which present arrangements could be better adapted to our times. Mr. R. Mawby, commenting on the report of the court of inquiry into the dispute at Briggs Motor Bodies, Ltd., Dagenham, and some of Lord Cameron's observations in that report, referred to the inappropriateness or inadequacy of the geographical basis of the normal branch membership of a trade union under modern conditions, and the consequent danger of a divorce between power and responsibility. In replying on the debate Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour and National Service, agreed that difficulties would largely be overcome by a larger and more representative attendance at branch meetings, but saw no other way of overcoming the problem. There was growing concern in the country about the working of the industrial relations system, both in regard to the settlement of disputes by negotiation without resort to strikes or lockouts, and in regard to our apparent inability to escape from the wage-price spiral, and the possibility of linking wage increases to productivity.

In a system of free industrial relations the answers to questions in this field must, Mr. Carr said, be agreed by the two sides of industry: the Government has a responsibility, but it can neither direct nor compel. Through the Minister of Labour it can, and should, try to guide and, without commenting on Mr. Cooper's suggestion, he promised the Minister would give it most careful consideration. The Ministry is doing its best continually to bring the two sides of industry together and in 1956 had initiated, through the National Joint Advisory Council, an inquiry, industry by industry, into the joint use of labour. Replies had been received from industries representing four-fifths of the labour force of the country and many reported no problems of this kind, while others already had, or were establishing, appropriate organization for settling them if they arose.

Mr. Carr thought that this was the most practical approach. There was no room for restrictive practices, either on the part of labour or of trade associations, but each practice had to be examined on its merits, especially at the local level by those really acquainted with the technicalities of the individual industry and practice. He thought it was most important that both sides of industry should acquire the habit of meeting together on problems other than wages. It was upon voluntary agreement in industry that good industrial relations depended, and this must start at the level of the individual factory. Here, too, the Ministry could help through its Personnel Management Advisory Service or its Training within Industry Service, but the real responsibility for leadership in the factory must rest with the management of each undertaking.

In pursuance of this the Ministry has recently issued a new booklet* "Positive Employment Policies". The first part of the booklet describes in general terms the objectives and content of employment policy based on the experience and practice of a number of firms in establishing and applying a positive employment policy. This is an integral part of managerial and product policy as a whole and aims at creating a co-operative, responsible and efficient working job. It will be concerned to promote satisfaction on the job and a sense of participation in an enterprise which the employee understands. It should provide opportunity for advancement and the security which fosters the confidence on which good industrial relations within a company, high productivity, and the ready acceptance of new methods largely depend. In this connexion special stress is laid on the importance of providing in advance against redundancy. Consultation and foresight can do much to reduce difficulties, particularly over such matters as the order of redundancy, length of notice and compensation.

The second, and major, part of the booklet gives detailed examples of actual practice and illustrates in particular the value of setting out in handbooks and in other ways the various aspects of an employment policy. Much of this again relates to the handling of redundancy problems, but there is a useful section on the presentation of financial results to employees. In a foreword, the Minister, Mr. Iain Macleod, stresses the importance of these developments as a contribution to good relations in industry. Industrial efficiency, he remarks, has always depended as much upon human factors as upon mechanical and technical resources. The active co-operation of employees at all levels, which high productivity and adaptability demand, is best achieved where workers understand the aims and plans of management and are confident that their interests are being safeguarded.

Addressing a conference at Port Sunlight on "Industry and the Nation", organized by the British Institute of Management, Mr. Macleod said that the booklet had been issued because he believed his Ministry could give a lead to managements and employers on employment policies. A firm should aim first at efficiency, for men wanted to work for an efficient organization; but they also wanted fair

* Positive Employment Policies: Examples of Management Practice contributing to Good Relations in Industry. Prepared by the Ministry of Labour and National Service and the Central Office of Information. Pp. 40. (London: Ministry of Labour and National Service, 1958.)

treatment, and a firm's second aim should be to apply to human problems the kind of forward thinking customarily given to technical and production matters. Thirdly, it was essential to help a man to feel that he was part of a team and managements should therefore assist individuals to develop their abilities to the full, by training facilities, promotion policies and suggestion schemes.

Sir Colin Anderson, president of the British Employers' Confederation, also referred to the booklet, but suggested that a similar publication with examples illustrating good trade union practice in dealing with their members would be useful. He was concerned, as had been Mr. Carr in the House of Commons debate last year, at the small proportion of members who took part in trade union activities. Although most leaders of the trade unions showed a high sense of responsibility, there was real danger of power being used irresponsibly by small groups. The danger which an irresponsible trade union could do could not be ignored.

Such views have been freely expressed in the press during the last two years or so, and a recent series of articles in *The Economist* attempted to formulate some constructive proposals which could minimize the risk of such irresponsibility, and also eliminate the restrictive practices, which, through the closed shop and the limitation of the right of choice of union, for example, have endangered personal liberty and inflicted suffering and injustice. Although such reform must come chiefly from within the unions themselves, they are problems which closely bear on the welfare of the nation as a whole, as well as on the freedom of individuals. Recent inquiries into the apprenticeship system, for example, have indicated that its rigidity in age structure is entirely contrary to the national interest in an age of rapid technological change. It involves hardship for individuals, as well as waste of precious manpower, if a skilled man is denied the opportunity of changing from one trade to another and learning a new skill outside the narrow age limits of 16 to 21, quite apart from all its repercussions on the recruitment to the Armed Forces and the return of discharged men to civilian life. Moreover, without foresight and reform, it is one that could increasingly affect the freedom of the scientist or technologist in industry.

What needs to be emphasized is that both Britain's industrial efficiency and economic survival may well depend on greater mobility in her industrial life. The development of new industries and the decline of old ones, the advent of automation and the economic use of new and improved equipment, the substitution of mechanical power for human labour in dangerous or unpleasant occupations, all make fresh and bigger demands on human intelligence and skill and involve displacement of men and women from obsolete or redundant occupations. There are problems of adaptability as well as of redundancy, and not all these are matters of technical training or of management. Some of them equally involve a new outlook and fresh thinking on the part of the unions themselves.

How to encourage leadership in the unions as well as in management is one of our vital problems and should not be forgotten at any level where the expansion of technical or technological education is planned. It goes far wider and deeper than the question of training for management, and because it involves fundamentally the conception that industry has a social, not merely a productive function, that the factory is a social unit and not just a group of machines, we are concerned too at every level in the educational system with the question of an adequate education. This must stimulate men and women to think soundly, widely and intelligently on life and citizenship. Their interests and horizons must not be limited to the acquisition of the technical skill or knowledge required for some particular craft or occupation or profession which they seek to enter in adolescence.

Narrow vision and limited interests constitute the major threats: power in the hands of small groups will be abused, and co-operation will be impeded and the confidence on which satisfactory human relations are always based will not be established. None the less it should also be remembered that the growth of what has been described by Sir Norman Angell as a new kind of power has implications for education as well as for management. In his presidential address to the Trades Union Congress last September Sir Tom Williamson gave the assurance that trades unions would not use the strike weapon for political ends, and there is no reason to doubt that responsible trade union leaders will continue to disparage and discourage the use of the power which particular, relatively small, groups possess of paralysing society for sectional ends.

Even if, however, the trades unions are more receptive of new ideas and readier to adapt their internal organization to change than might appear from either the response of the Congress to Sir Tom Williamson's address or from the reception given to the Cohen Report, a courageous and searching lead at the national level can scarcely achieve effective reform unless its purpose and necessity are clearly understood at the factory and local level. To devise, for example, a form of trade union organization which will foster both the proper pride and interest of the individual in his particular job, and a sense of corporate responsibility throughout the larger groups of modern industry, cannot be done from the top or by theory alone. It demands co-operation at all levels, effective and loyal enough to the larger ideals to hammer out in practice the new organization and test thoroughly the changes proposed.

The new flexibility demanded on all sides of industry and at all levels is not something to be acquired by technical training alone, though that must play an essential part. Technical and technological education alike must seek to enable the student to understand the setting in which he will be called upon to use his skill, to see its relation to the needs and purposes of society as a whole, to foster not simply a professional or craft loyalty to the working group in which he will take a place, but a wider and deeper loyalty to society

as a whole. Vision and some sense of moral responsibility must be imparted; and an educational framework which does not seek to foster at least some elements of these at all levels from the skilled craftsman or technician, the scientist and technologist, to the manager and administrator and minister is inadequate for our present needs.

On how this is to be achieved there are and will be widely differing views, but as to its urgency there can be no doubt. It must be kept in mind in planning the expansion of the secondary modern school in relation to the technical colleges which could contribute substantially to securing a sufficient number of able children to such careers. While the development of good industrial relations and sound employment policies along the lines suggested in the booklet "Positive Employment Policies" should go far to clear the way, much closer co-operation between industry and the technical colleges and between the colleges of technology and the universities is also needed as a basis for hammering out the kind of courses best calculated to develop the qualities needed in the industrial society of to-day.

If we are indeed to seize the opportunity which the "time for greatness" of which Lord Chandos wrote last year offers us, full use must be made of the existing tradition and practice of good labour relations, of industrial loyalty and avoidance of strikes, as of the possibilities inherent in a time of educational development at all levels. Education has much to contribute if its leaders can rise to their opportunity and secure the internal co-operation and flexibility needed as well as the co-operation with industry. Government has its responsibilities for seeing that the resources available for educational change and expansion are commensurate with national requirements and neither limited nor wasted by local or sectional parsimony, rivalry or short-sightedness.

It cannot be said that the sole or even the major responsibility rests upon the management side of industry. That management must give the lead towards the new flexibility that an age of automation and rapid technological change demands is not denied, and unless the employment policies of industry are appropriate we can scarcely expect the trade union side of industry to tackle resolutely the difficult problems, and obsolete and inappropriate restrictive practices in apprenticeship or in organization generally. None the less, while the action and policies of managements and educational developments can do a good deal to remove obstacles and to encourage a forward outlook, the responsibility for trade union reform, for the modification of organization and the encouragement of flexibility rests unmistakably on the leaders of the trade unions. Problems of technological change, of flexibility, of higher productivity and industrial efficiency will only be solved in the measure in which they are willing to face their own problem of power and responsibility, and to take their part in the evolution of the means required to-day to ensure that Britain's limited resources of man-power are fully and efficiently used, with neither loss to the nation nor frustration or injustice to the individual.

INDUSTRIAL CIVILIZATION

Cultural Foundations of Industrial Civilization

By Prof. John U. Nef. (The Wiles Lectures given at the Queen's University, Belfast, 1956.) Pp. xv+164. (Cambridge: At the University Press, 1958.) 20*s*. net.

THE book is based upon six lectures on European civilization in the sixteenth and the seventeenth centuries delivered by the author in The Queen's University, Belfast, during 1956. Prof. J. U. Nef is a well-known and much respected economic historian, head of the Committee for Social Thought in the University of Chicago and author of the standard work on the early English coal industry. Nevertheless this book is not an economic treatise nor an essay on the rise of modern industry, but a description of cultural changes in the two centuries following the Reformation; a description into which the economic strain enters but which it never dominates.

Needless to say the author does his best to relate this strain to the other *motifs* in his composition, and to display economic changes as part of intellectual, moral and even æsthetic movements of the age. In this he is mostly successful, although at some points the interrelations appear less obvious than at others. Thus for all his erudition, the author does not quite manage to establish the connexion between the luxury trades of the age of Louis XIV and that upsurge of economic activity which we associate with the Industrial Revolution. The industries of the French baroque and rococo turned out costly artefacts in relatively small numbers, whereas the main achievement of the Industrial Revolution was to cheapen and to standardize industrial output (Adam Smith's pins) and thereby to open up the mass markets of the world. Readers may also find it difficult to connect, at any rate directly, the rise of modern industry with the new religious temper of charity, love and toleration which, as Prof. Nef so eloquently and convincingly argues, replaced in the late seventeenth century the fanatic intolerance of the earlier age.

Much closer and obviously more important were the connexions between the new science and the rising industry. Prof. Nef's account of new science is of necessity too brief and too second-hand to add new facts to what recent writers such as Prof. Butterfield or Mr. Hall have already told us. It nevertheless performs a very useful service by singling out for special emphasis one or two significant trends. Here again some readers may think that the author exaggerates the direct contribution of new scientific knowledge to technological change. Neither the spinning jenny, nor the mechanical loom, nor even Darby's and Huntsman's innovations in the making of iron and steel (and certainly none of the changes in the coal industry, not even Newcomen's engine) owed much to recent scientific discovery. But most students will agree with Prof. Nef's general assumption that in the seventeenth century both science and industry reflected a common attitude of mind, questing, critical and empirical. In this context especially valuable is the author's account of the growing pre-occupation of the age with measurements and quantities. The quantitative outlook of seventeenth-century science also entered into economic discussion and perhaps even into the conduct of business.

Too much, however, should not be made of the demonstrable connexions between industrial and

other aspects of seventeenth-century culture. It is not Prof. Nef's object to look to contemporary science, religion or æsthetics for an explanation of the industrial developments of that and the following centuries. The most characteristic and the most attractive feature of the book is its endeavour to treat the civilization of the age as one; and to distribute the stress evenly between the various human activities and attitudes which went to make the culture of Europe in its last pre-industrial phase. If some of these activities and attitudes happened to be interrelated—as in Prof. Nef's showing some of them certainly were—this does not by itself provide an explanation of economic growth or of the Industrial Revolution.

Indeed, one of the most striking uniformities emerging from Prof. Nef's story fits very inconveniently into the chronology of economic development. It is impossible to read the book and compare the dates in its different chapters without noticing how closely synchronized in time were the main phases of scientific, moral and æsthetic evolution in the seventeenth century, and how different in all these respects was the second half of the century from its opening decades and from the sixteenth century. There was some contrast also in the economic sphere, but curiously enough the seventeenth century differed from the sixteenth mainly in having failed to sustain the earlier pace of economic and technical change.

'COMPREHENSIVE' INORGANIC CHEMISTRY

Comprehensive Inorganic Chemistry

By Prof. M. Cannon Sneed and Prof. Robert C. Brasted. Vol. 5: Nitrogen, Phosphorus, Arsenic, Antimony, and Bismuth. By Harry H. Sisler. Nonaqueous Chemistry. By Alfred R. Pray. Pp. x+214. 37*s*. 6*d*. net. Vol. 6: The Alkali Metals. By John F. Suttle. Hydrogen and Its Isotopes. By Robert C. Brasted. Pp. viii+234. 45*s*. (Princeton, N.J.: D. Van Nostrand Company Inc.; London: D. Van Nostrand Company, Ltd., 1957.)

THE four parts into which these two volumes are divided are individually moderately satisfactory. They are all primarily descriptive. As in previous volumes the authors sometimes attempt a thorough survey of a topic, and sometimes put all the emphasis on recent advances; nevertheless, there is usually a reasonably good balance.

Perhaps the least satisfactory is the chapter on non-aqueous solvents. Here a more fundamental approach would have been an advantage. As it is, a few solvents are selected for descriptive treatment, and for other solvents the reader is referred to other parts of the series. Valuable comparisons are thereby lost. Moreover, in one case at least (nitric acid) the reader may be disappointed when he does refer elsewhere. It may also be noted that alcohol and acetone are not considered at all; this cannot be because they are organic compounds, since acetic acid is included.

Even if these four parts pass muster in general, there are a number of unsatisfactory points of detail. There is, for example, a short section in Vol. 5 on the not very important isotopes of nitrogen, yet the only mention of phosphorus-32 is in a table of isotopes. The numerical data in Table 2.3 of Vol. 6 do not tally with those in Table 2.10. Liquid ammonia as a solvent is treated at some length in no fewer than three of the four parts, and there is considerable overlap in the information provided. In the discussion on acetic acid as a solvent, space is found for the irrelevant fact that wine vinegar has been made in Orleans for centuries. A minor curiosity is the use of the word 'moiety' for the species H_3O^+ and NH_4^+—'entity' is presumably intended; and something has gone wrong with the contents page of Vol. 6.

Some of these criticisms should clearly be laid at the editors' rather than the authors' door. Editorial policy appears indeed to be lacking in definition. The preface, which sets out to state the policy, proves on examination to be a confusing document. For example, the series is not to be "an encyclopedic work", yet it is to be "a ready reference" and it is to be "comprehensive". But what is the difference between an encyclopædia and a comprehensive reference work? And what are we to expect of a reference work that warns us that "terms are used with or without definition", and that "many inorganic compounds are not mentioned at all"?

Such editorial vagueness has made the series inconsistent and uneven. Thus in "The Alkali Metals" there are no fewer than 164 diagrams, of which the great majority are phase-rule diagrams. In the volume on the nitrogen family the shapes of several dozen molecules are indicated. If these were constant features of all the volumes, one could rely on them and make use of them; but they are not.

Is it too late to hope that the editors will come to a clear decision what to include and what to omit in the remaining volumes of the series?

TROPICAL MEDICINE

Lehrbuch der Tropenkrankheiten

Herausgegeben von Prof. Ernst Georg Nauck. Unter Mitarbeit von G. Fuhrmann, H. Knüttgen, H. Lippelt, W. Minning, W. Mohr, H. Mühlpfordt, E. Reichenow, H. Vogel, A. Westphal und F. Weyer. Pp. viii+432. (Stuttgart: Georg Thieme Verlag, 1956.) 64 D.M.

A NEW manual of tropical diseases in the compass of only 432 pages, clearly printed on semi-glossy paper with numerous illustrations, is a welcome addition to the literature; when it is under the editorship of Prof. Nauck and written in collaboration with well-known members of the Hamburg Tropical Institute, it is indeed an event. The book will doubtless be used as their chief text-book by members of the classes attending the courses at the Institute; it will also form a handy book of reference for anyone wanting to obtain easily information on tropical medicine. This is because it is up to date, accurate and arranged so clearly that even a reader not very familiar with the language can quickly find the knowledge he wants. Nauck states in the introduction that the book is not intended solely for their own students but for all doctors actually working in the tropics.

The text opens with a useful summary of the part played by arthropods in tropical diseases and provides a few diagnostic keys, which will enable the student to get started on this important aspect of the subject.

Next come eight sections devoted respectively to diseases caused by protozoa, spirochætes, bacteria, rickettsiæ, viruses and fungi, and these are arranged on a uniform plan, expanded for important parasites like those causing malaria, or reduced to a few paragraphs in the case of the rarer infections.

The diseases are described under the following headings: etiology, transmission and epidemiology, pathogenesis including morbid anatomy, signs and symptoms, diagnosis, treatment and control. Very clear photographs (including electron micrographs) illustrate this part of the text, which is accompanied also by useful tables of classification, diagnosis, etc. In a book of this size, condensation of detail is inevitable, but the major features of each disease are indicated and, as might be expected from the country of origin, the chemotherapeutic sections are particularly authoritative. There are a few minor points of criticism, such as the inclusion of *Toxoplasma* among the flagellates, the omission of 'mega' from the pathology of Chagas's disease and the only partial acceptance of *Plasmodium ovale* as a valid species; but these are perhaps matters of opinion.

The last three chapters deal with intestinal disorders, diseases of doubtful etiology and the effects of venomous animals such as snakes, scorpions and spiders.

The common methods employed in diagnosis are briefly described in different sections of the book, the examination of blood and fæces for protozoa in one part, cultural methods in another, concentration techniques elsewhere, etc., and it might be desirable in a future edition to collect this information in a final chapter for easy reference.

P. C. C. Garnham

VISION AND THE EVOLUTION OF MAN

The Vertebrate Visual System

Its Origin, Structure, and Function and its Manifestations in Disease, with an Analysis of its Role in the Life of Animals and in the Origin of Man. Preceded by a Historical Review of Investigations of the Eye, and of the Visual Pathways and Centres of the Brain. By Stephen Polyak. Edited by Heinrich Klüver. Pp. xviii+1390 (546 figures). (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1957.) £16 17*s.* 6*d.*

IT is difficult to review a book of the quality and comprehensiveness of this work in a few hundred words, but it is a magnificent contribution to the biology and psychology of vision. The book has had a somewhat sad history, because the author, Stephen Polyak, was threatened with death or total blindness during the work, and in 1955 he died, leaving the completion of its publication to the distinguished services of his friend and colleague, Prof. Heinrich Klüver. The difficulties with which Klüver had to contend, and the courageous way in which he faced them and completed his task in the manner in which Polyak would have wished, are revealed in the foreword, but can well be imagined by anybody who has passed even a much smaller and less comprehensive work through the press.

The book is divided into four large parts. The first is about the history of investigations of the structure and function of the eye, and of the visual pathways and centres of the brain. This is a most fascinating historical survey, enlivened with many early diagrams and the portraits of distinguished workers, such as Vesalius, Kepler, Malpighi, Ramon y Cajal and many others. It is interesting to see the early attempts to represent the optical system of the eye in diagrams, to compare the detail of Leeuwenhoek's microscope with those of James Wilson, Marshall and Cuff, to see the early representations of retinal structure and to compare them with those of to-day.

The second part, also enlivened with many portraits and diagrams, is about the anatomy and histology of the retina and of the visual pathways and brain centres. This part is tremendously important, and it is here that Polyak's own brilliant work is to be found. The structure of the retina, of the optic nerves, chiasma, tracts and subcortical and cortical visual centres are treated in great detail. The general theory of the organization of nervous systems in relation to vision, and the blood supply of the vertebrate visual system, receive separate and detailed chapters. The third part of the book is about the pathology of the retina and of the visual centres and pathways. Disturbances of visual functions and clinical and patho-anatomical observations on cases of visual disorder are dealt with, and their study is most valuable.

The fourth part, which may be of more interest to the general biological reader, is a review of the origin and development, the comparative anatomy, physiology and biology of the organs of sight. The last chapter of this section, and the last in the book, deals in a most interesting way with vision and its role in the evolution of vertebrates and the origin of man. There are many delightful sections, beautifully illustrated, dealing with the visual systems and functions of vertebrates, including birds, the tree shrews, squirrels, the tarsier, lemur, macaque, baboon, gibbon, gorilla and chimpanzee, with valuable accounts of their general biology and mode of life. The importance of the diurnal habit, upright gait, of binocular and stereoscopic vision, and, of course, the supremacy of visual perception over the functions of other exteroceptive forms of perception, are given full weight. One of the most interesting and illuminating sections is about the re-emergence of colour vision among the higher apes after it had been lost by the lower mammals, and its importance in primate evolution.

The views of Elliot Smith on the evolution of man are given due weight, and, according to Polyak, the three principal factors on which rest the physical character and intellectual supremacy of man are vision, the manipulative ability of the arms and hands, and the locomotor ability of the legs and feet in relation to the upright gait. Hearing must take second place to vision, he says, despite its tremendous importance in relation to speech and language, and the other senses are far below. In spite of the obviously great importance of vision, manipulative activity and locomotion, it seems that Polyak may have underestimated the importance of hearing and speech for man's supremacy. Unless coupled with language and speech, vision would never have produced man by its biological development, even if combined with manipulative and locomotory activities. It seems, therefore, that hearing and speech should be put on a level with vision and manipulation.

When it is realized that the book contains no less than 546 figures in the text and many coloured plates,

together with a bibliography of about 10,000 references in addition to the special lists of references for most sections, it will be seen that it is a mine of information for ophthalmologists, physiologists, biologists and psychologists, and it will remain a great source book for many years to come. Although it is such a comprehensive and learned work, it is pleasantly written and eminently readable. Our warm thanks are due to Prof. Heinrich Klüver for his devotion to the task of completing the work and seeing it through the press.

R. W. Pickford

DRUGS AND THE BRAIN

Chemotherapy and the Central Nervous System

By Dr. Henry McIlwain. Pp. viii + 328. (London: J. and A. Churchill, Ltd., 1957.) 45*s*. net.

Neuropharmacology

Transactions of the Third Conference, May 21, 22 and 23, 1956, Princeton, N.J. Edited by Harold A. Abramson. Pp. 381. (New York: Josiah Macy, Jr. Foundation, 1957.) 4.50 dollars.

THESE volumes are two of an increasing number of books dealing with the biochemical and pharmacological problems of the most complex of living tissues. They do, however, represent different extremes in approach to the subject. In one, an eminent research worker and teacher surveys the whole field of chemotherapy, past and present, in relation to the nervous system: in the other, we can read a more-or-less word-by-word account of a conference in which a group of no less eminent scientists discuss many current problems of the pharmacology of the central nervous system.

The task of Prof. McIlwain was formidable. Of all diseases, those of the nervous system are among the most intractable and present the greatest challenge to science; it is therefore to the author's credit that he has given a clear account of present and past methods of chemotherapeutic attack, while at the same time emphasizing the general principles of chemotherapy as a subject in its own right. Of further interest to the general reader is the emphasis given in the early chapters of the book on the history of the subject. The mid-nineteenth century researches of Snow on the action of ether and chloroform are considered in detail, as in a later chapter are the more familiar studies of Erhlich with arsenicals.

But this does not detract from the use of the book as an up-to-date text. In fact, when one considers the length of the book, the field covered is vast. The control of body temperature, the metabolism of drugs, convulsants and anti-convulsants, analgesics and antibiotics—all are included. There is a succinct but thoughtfully written section on tranquillizing drugs that reflects the scepticism of an authoritative investigator.

The subject-matter is meticulously documented with a list of references at the end of each chapter. Where suitable, information is summarized in the form of tables and graphs, which makes for easy reference; there are both a subject and author index, the former more than adequate. This book seems likely to pass through several editions.

The Transactions of the Third Conference of Neuropharmacology make perhaps for lighter reading. In the preface it is stated that "the goal of this conference . . . is the promotion of communication, the exchange of ideas and the stimulation of creativity among the participants". Selected research projects are introduced by the worker involved and the ensuing discussions have apparently been recorded in full. The individuals taking part in the conference came from many different scientific disciplines and the main interest of the book derives from the *rapport* between the participants whose contributions appear in the form of question and answer. Some of the questions, it might be added, are not answered; nevertheless, this technique can be very effective, as in the section devoted to the action of alcohol on the nervous system.

The subjects discussed vary in interest and importance. There is a long and interesting section on the effects of psychomimetic drugs in animals and man (Prof. J. Elkes); and a study of serotonin and norepinephrine as antagonistic chemical mediators in the central nervous system is effectively given by Dr. B. B. Brodie. Other subjects, for example, the effects of lysergic acid diethylamide on snails, are perhaps more esoteric.

Some of the passages in the discussion seem to me to be of a trivial nature and scarcely worth recording, for example:

"R. Is this commercial epinephrine solution or is it specially prepared?

"J. It was a saturated solution of epinephrine made from the dried base.

"A. It was 1 to 6,000.

"R. Was it made as a pharmacologic solution?

"A. It was a solid base added to the solution."

On the other hand, the book is well produced on high-quality paper, is adequately illustrated and is complete with subject index. For an American publication its price is very reasonable (through the generosity of the Josiah Macy Jr. Foundation it is sold at cost), and it certainly gives the reader an insight into contemporary trends in neuropharmacological research.

G. B. Ansell

BASIC ZOOLOGY

Principles of Zoology

By Prof. John A. Moore. Pp. xiv+667. (London and New York: Oxford University Press, 1957.) 60*s*. net.

ASKED recently what she would expect to find in a book entitled "Principles of Zoology", a young student volunteered the answer, "the main things you would need for an examination". For reasons not entirely based on false etymology, the reviewer approached Dr. Moore's book with similar misgivings, which turned out to be quite unfounded. This is a genuine and surprisingly successful attempt to give zoological concepts and principles first place and to reduce the memory work of mastering intricate detail to a minimum.

The book is a first-year text designed for an American liberal arts college, for students with no previous knowledge of the subject. The author says in his preface that in order to illustrate the methodology, philosophy and strategy of science, "superficial treatment of a wide variety of topics must be sacrificed for a meaningful consideration of a few". He selects for these few (*a*) cytology and 'classical' genetics, (*b*) embryology and (*c*) evolution, and not many will quarrel with his choice; his detailed handling of these topics is preceded by an introductory section of 140

pages in which the biology of the frog and the elementary principles of zoological classification are followed by a 'Cook's tour' of the invertebrate phyla.

The backbone of the book is provided by the section on the development of genetic concepts which starts, rather surprisingly, with a detailed analysis of Darwin's theory of pangenesis—emphasizing that this was in fact perfectly consistent with the evidence then available. A largely historical treatment of classical cytogenetics follows and the student is led step by step through the evidence for linear arrangement of the genetic factors on the chromosome.

A third section introduced by a synopsis of the development of the frog leads the way to an analysis of embryological concepts—from the earlier antithesis of preformation and epigenesis, through mosaic and regulative development to the concept of the organizer.

The section on evolution starts with Darwin and Wallace on the origin of species and provides the opportunity at this point for a survey of the chordates. As a natural consequence of the earlier genetical and embryological emphasis, the way is well prepared for a careful presentation of the mechanism of evolution. Such topics as the change of gene frequency in a population, patterns of speciation and isolation, changes of ploidy are all treated convincingly at quite an advanced level.

The book is completed by a section on human physiology which is almost an appendix, only distantly related to the pattern of the earlier parts. With this exception, the work impresses the reader particularly with the very carefully designed order in which its material is arranged, by its careful documentation and illustration of the evidence presented and by the stimulating feeling it gives to the reader of an active and growing science. A first-year course based on this plan would be a fascinating subject for experiment in a British university.

JOHN E. HARRIS

ENZYMOLOGISTS' 'DO-IT-YOURSELF' MANUAL

Methods in Enzymology

Edited by Sidney P. Colowick and Nathan O. Kaplan. Vol. 3. Pp. xxiv+1154. 26 dollars. Vol. 4. Pp. xii+979. 24 dollars.

(New York: Academic Press, Inc.; London: Academic Books, Ltd., 1957.)

THESE two volumes complete the set of four which make up this treatise on laboratory techniques for enzyme studies. The first two, dealing with the preparation of enzymes, have already been reviewed in this journal (*Nature*, **177**, 810; 1956; and **178**, 509; 1956). Volume 3 is on the preparation and assay of substrates and Volume 4 on special techniques for the enzymologist. Like the earlier volumes they consist of articles by many different authors, with consequent variations of style and content, but between them they cover an immense and useful field.

Volume 3 is divided up into seven sections on the basis of the chemical nature of the substrates discussed: proteins, carbohydrates, lipids, citric acid cycle components, nucleic acids and derivatives, and coenzymes and related phosphate compounds, the final section being about the determination of inorganic compounds. In each section both preparation and estimation of the main substrates are described, and in a great many cases both chemical and biological methods are given.

One result of this layout is that some general topics are dealt with in many parts of the book. The most striking case is chromatography, which is now perhaps the 'special technique' most universally used by biochemists. It is not discussed as a special technique in Volume 4, although the somewhat analogous process of paper electrophoresis is to be found there. However, there is plenty of space devoted to chromatography in Volume 3: the chromatographic separations of sugars, acids of the citric cycle, amino-acids, and nucleotides are described in some detail, and the chromatography of organic acids is dealt with in two sections, on pp. 377 and 397. In each case some space is devoted to a description of the apparatus required and the basic manipulations; a particularly useful account of paper chromatography is given in connexion with amino-acid analysis on p. 504. It seems to the reviewer that the space devoted to chromatography might usefully have been collected into one section; to a lesser degree this is true of other techniques, for example, microbiological estimations.

Volume 3 contains many useful features which are not easily found in the original literature without a great deal of research. To mention a few at random: the empirical colour reactions for identification and determination of sugars are collected together in a concise account; the methods given for preparation of sugar phosphates include the older, classical methods, sometimes with more recent modifications, side by side with newer, chemical methods; and a very useful table of hydrolysis constants of phosphates of sugars and related compounds is given on pp. 847–48. On the other hand, some of the methods given can only be described as exotic, and are scarcely likely to become routine procedures in many laboratories; for example, the estimation of adenosine triphosphate by measuring light production with a crude firefly luciferase preparation. Nor is the preparation of compounds such as γ-carboxymethyl-Δ^{α}-butenolide likely to interest more than a small group of enzymologists.

In some sections the long time needed to collect the articles for volumes of this size is very obvious. A detailed description is given of a biological method for the estimation of carnitine, using *Tenebrio molitor*. Although the volume bears the publication date 1957, this article carries a footnote dated September 1956, saying that the method described has not been working satisfactorily in the authors' laboratory since 1953!

The final volume describes a very arbitrary selection of special techniques. More than half is devoted to techniques used in isotope studies; a short account of the measurement of radioisotopes and stable isotopes is followed by an exhaustive account of methods for preparing and degrading labelled intermediates. Other techniques dealt with are those used for the characterization of proteins, the difference spectra methods for metabolic studies developed by Chance, and electron microscopy of intracellular structures. The last mentioned is illustrated by some excellent photomicrographs of cell sections.

The whole set of four volumes forms a practical manual to which every biochemist will wish to have access. It is well documented, and even if it does not contain exactly the details one requires, it will usually serve as a lead into the appropriate original literature.

EDWIN C. WEBB

Radio Astronomy

Edited by H. C. van de Hulst. (International Astronomical Union Symposium No. 4, held at the Jodrell Bank Experimental Station, near Manchester, August 1955.) Pp. xi+409. (Cambridge: At the University Press, 1957.) 50*s*. net.

PRIOR to the main assembly of the International Astronomical Union in the late summer of 1955, a symposium on radio astronomy was arranged at the Jodrell Bank Experimental Station of the University of Manchester. This important meeting brought together most of the leading radio and astronomical workers taking part in this expanding field of research. The book is a collection of the eighty papers contributed to the symposium, together with succinct reports of essential parts of the discussions. Minor revisions and notes of more recent results have since been introduced, and the book provides a valuable guide to the developments in radio astronomy now being pursued in different parts of the world.

Although meteor astronomy is included, the main emphasis of the symposium is on the observation and interpretation of spectral line and continuous radiation, discrete radio sources and the problems of their identification, and radio emission from the quiet and active Sun. The spatial distributions of the interstellar radiation and of the localized sources are considered in relation to the structure of the galaxy. There are several papers on theories of the origin of non-thermal radio emission.

As the results of research in radio astronomy are published in many journals of various countries it is particularly valuable to have available the account of a symposium such as this in which principal lines of work and progress are summarized. The different parts of the symposium include useful introductory surveys which put the various papers into perspective. The book is excellently produced. J. S. Hey

Reports on the Progress of Applied Chemistry

Vol. 41, 1956. Pp. 795. (London: Society of Chemical Industry, 1957.) 100*s*.

THIS indispensable annual now appears in a more attractive binding, which may provide some compensation for the very high price. A good feature is the inclusion of supplementary references at the ends of many sections, giving publications not specifically referred to in the text. A large proportion of the references are to American sources, and one reason for this is pointed out by Dr. Hardie in the section on acids, alkalis and salts, namely, that British manufacturers are much less inclined than their trans-Atlantic counterparts towards providing information. Out of 260 items in Dr. Hardie's bibliography, only 30 or so refer to British developments. This is a matter which the information organizations of the firms concerned should treat seriously, since they are losing face.

So much information is contained in the volume that it is possible only to mention one or two items. Seven new phases in crystalline and vitreous silica have been described. The process of zone refining in purifying metals has increased the purity of aluminium from 99·997 to 99·9995 per cent in laboratory work and it is to be expected that the physical properties of pure metals will now for the first time soon be available. In the use of germanium in transistors, very high purity is essential. The industrial use of zirconium requires that the hafnium shall be practically all separated. A blast furnace method of zinc extraction is being successfully operated. Out-moded dyes such as Doebner's violet are coming back into use with synthetic fibres. In the section on tranquillizing drugs it is stated that, while there is a considerable demand for them, there is criticism in medical circles of their indiscriminate use. Attention is being given to the possible use of acetoglycerides as food, and various enzyme concentrates in bread-making. The deterioration of food in deep freezing is being offset by various additives after treatment. The problem of the emergence of synthetic detergents in sewage and water supplies continues to offer difficulties. J. R. Partington

Man and Mammoth in Mexico

By Dr. Helmut de Terra. Translated from the German by Alan Houghton Brodrick. Pp. 191+17 plates. (London: Hutchinson and Co. (Publishers), Ltd., 1957.) 25*s*. net.

AS the dust-cover indicates, this is one of a series of travel books, and it would be perhaps unfair to expect it to be a contribution to knowledge. It consists of an assorted collection of scraps, based on Dr. Helmut de Terra's travels and studies in Mexico and Guatemala. There are visits to the snow-line and to the new volcano of Paricutín; trips to archæological sites here and there; a heartfelt cry about soil erosion, and the old story of Tepexpan man, spiced with some good photographs which give local colour even if they are not all of obvious relevance to the text. The map on the end-papers retains some words in the original German.

De Terra's field of study lies on the border-line between archæology and geology, and he is known particularly for his part in the discovery of the Tepexpan skeleton, belonging to a man who, he claims, lost his life when hunting mammoth. He may be right since it is known that mammoth were killed by man at Istápan nearby, but unfortunately it is not certain that the skeleton is contemporary with the deposit in which it and the mammoth were found. The matter can only be settled by the discovery under proper conditions of another skeleton, and de Terra begs the question by repeating, as he does here, that the bones "must be as old as the other fossils found in the same level. We had discovered the first man from the late glacial strata of Central America", Elsewhere he claims to have found artefacts which "afforded the first proof of very early man in Guatemala" but gives no details. Since the book covers the period 1946–52, this discovery, if it amounted to anything, would surely have been published by now, but it is not even mentioned in the new edition of Wormington's "Ancient Man in North America", which contains notices of all the recent discoveries of importance, whether published or not.

There are numerous other references to archæological matters, and no one need complain that, in a travel book, they are not very informative or the author has used his imagination, but there are a number of irritating minor mistakes in the facts which could easily have been avoided. Apart from this, the statements that stone spear-points are "known by the technical name of 'Folsom Culture'", and that Folsom man is "mysterious" sound more like the writing of a journalist than of a scientist, but perhaps the translator is responsible. Finally, "the mighty empires that lasted for more than a thousand years before Cortes and Pizarro" are even more of a mystery to this reviewer. G. H. S. Bushnell

ATOMIC ENERGY DEVELOPMENT IN AUSTRALIA

THE Laboratories of the Australian Atomic Energy Commission and the first Australian nuclear reactor were opened on April 18 by the Prime Minister, the Right Hon. R. G. Menzies, before a gathering of a thousand distinguished citizens and members of the Diplomatic Corps. Situated at Lucas Heights, twenty miles south of Sydney, the new laboratories stand on a 160-acre site and comprise the steel shell reactor building itself (with supporting laboratories, workshops and experimental areas around the reactor), laboratories for chemistry and chemical engineering, library and administrative buildings, gatehouses, garages, stores, boiler house, liquid metal laboratory and effluent control laboratory.

The Australian Atomic Energy Commission was created in April 1953 by an Act of Parliament which gave it statutory powers within the constitutional authority of the Commonwealth Government. The present composition is: *Chairman*, Prof. J. P. Baxter; *Commissioners*, Sir Leslie Martin, Dr. H. G. Raggatt and Mr. H. M. Murray, with Mr. Alan McKnight as executive member. The Commission was charged with responsibility for the discovery and production of uranium and other nuclear materials such as thorium and beryllium, the development of atomic energy for industrial and other purposes, the development of scientific research within the Commission, and the training of scientists and engineers to meet the needs of nuclear technology in Australia.

In the early years of the Commission's activities, uranium production facilities were built at Rum Jungle and, through the South Australian Government, at Radium Hill, while more recently the Mary Kathleen field has been developed. Plans for the creation of the atomic energy research establishment were submitted to the Government in September 1954, and construction work was begun at Lucas Heights in October 1955. In recruiting staff, the Commission was fortunate in being able to draw on a reservoir of Australian and New Zealand personnel already having considerable research experience gained in United Kingdom, Canadian and American atomic energy establishments. While the laboratories were under construction, a vigorous group of workers, covering a wide range of disciplines, were accommodated at the Atomic Energy Research Establishment, Harwell, where further experience was obtained working on the British programme. When the decision was taken to build a high-flux research reactor for the work at Lucas Heights, it was natural for the group to turn to British experience. The design chosen is basically similar to Harwell's *DIDO*[1,2], full design information for which was made available by the United Kingdom Atomic Energy Authority and the Ministry of Works.

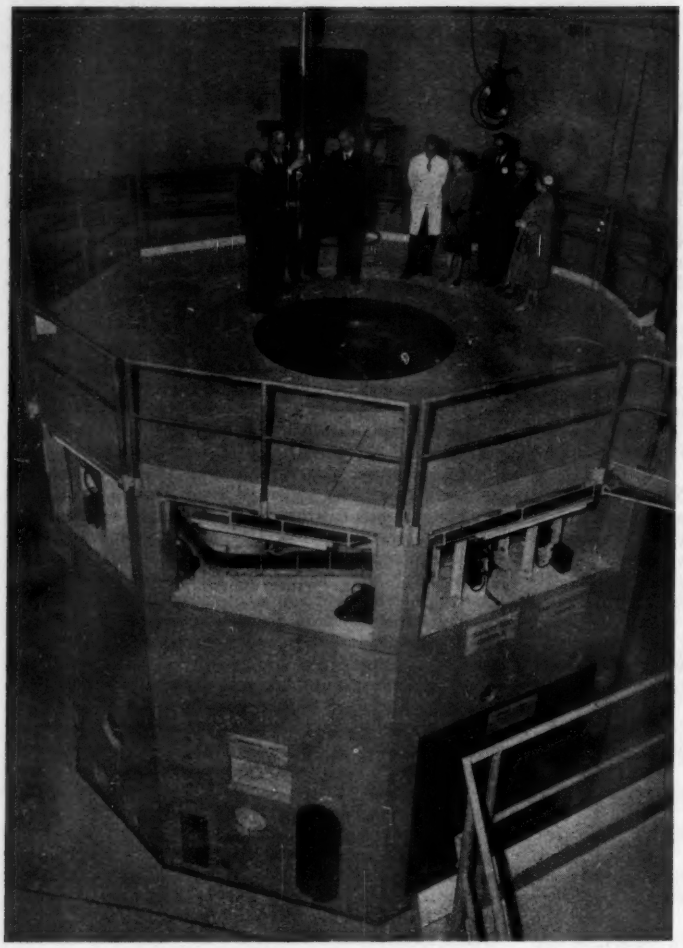
The Australian version of the reactor has some modifications and has been named *HIFAR* (High Flux Australian Reactor). It is rated at 10 MW. (heat), has a maximum flux of 10^{14} neutrons/cm.^{2}/sec., uses heavy water as moderator and primary coolant and ordinary water as secondary coolant, passing through cooling towers. A 60-cm. heavy-water reflector is supplemented by 60 cm. of graphite, and a barytes concrete shield 5 ft. in thickness provides biological protection. Enriched fuel is employed, the fuel elements being in the form of uranium–aluminium alloy plates arranged in an approximation to a cylinder of length 60 cm. and diameter 86 cm. The reactor core was constructed in England by Head Wrightson Processes, Ltd., and contains some 2·5 kgm. of uranium-235.

The necessary buildings, foundations and steel-work were begun in October 1955, and the first criticality tests were successfully carried out on the completed reactor on Australia Day (January 26, 1958). This work was under the direction of the Commission's chief scientist, Mr. C. N. Watson-Munro, who now has the unique distinction of being responsible for the first Canadian, first United Kingdom and first Australian reactors. Because only one reactor was planned for the preliminary phase of the research programme, a wide range of experimental facilities has been incorporated to enable radiation from the pile to be used and for subsequent examination of irradiated samples.

In particular, some sixty experimental holes have been provided, varying in size from 10 in. down to 2 in. in diameter. Holes 4 in. square pierce the thermal column and two 8 in. × 12 in. horizontal holes pass right through the graphite reflector. Thermal fluxes in these holes range from 4×10^{12} to 9×10^{13} n/cm.^{2}/sec., and the maximum epithermal fluxes are of the same order as the thermal flux for holes entering the heavy water, but are very much lower in the graphite reflector. High fast-neutron fluxes can be obtained by the use of a special uranium-235 thimble. The thermal column has a 1·6-m. square cross-section and is 1·3 m. long. The diffusion length of thermal neutrons in the graphite is some 50 cm., this resulting in a maximum thermal flux of 10^{13} n/cm.^{2}/sec. in the column. Nine 4 in. × 4 in. access holes are provided which are normally filled with graphite inserts. In due course, a neutron velocity selector, a crystal spectrometer, post-irradiation facilities, 'rabbits' and full-element irradiation facilities will be provided[3].

The research programme of the laboratory is aimed primarily at developing new types of power reactors for the economic production of nuclear energy (having in mind special Australian conditions), at studying problems associated with the large-scale handling of radioactive materials and the production and use of radioisotopes—especially those of short life which were unavailable in Australia prior to the completion of *HIFAR*[4].

Work has already been started on two power reactor systems which appear well suited to Australian conditions. One is a high-temperature gas-cooled system directed towards the development of a thermal breeder reactor with thorium as the fertile material and a highly enriched gas-cooled fuel element operating as much above 600° C. as may be possible. Beryllia, beryllium and graphite are being considered as moderators for the system. The second is a reactor



Australian News and Information Bureau

Fig. 1. The Australian atomic reactor *HIFAR*

system with liquid metal, using a sodium slurry as a coolant and fuel carrier, with beryllium as the moderator.

Loop experiments relating to these systems will be carried out in high-flux regions of *HIFAR*, and irradiation effects on nuclear reactor materials will also be studied.

A further major part of the research programme is the chemical processing project, in which the chemistry, chemical engineering and other sections will investigate problems in the recycling of reactor fuels. The separation of fissile and fertile material is an essential part of a nuclear power programme, and the design and construction of a small-scale solvent extraction processing plant are in hand.

As in other laboratories of this kind, the work of the new establishment is organized on a project basis with joint teams of scientists and technologists participating. The various sections are engineering research, engineering services, reactor physics, technical physics, health physics, chemistry, chemical engineering, metallurgy, isotopes, medical physics and administrative services.

The opening ceremony was marked by excellent speeches from Mr. Menzies and from the Minister in charge of the programme, Senator the Hon. W. H. Spooner. The intense interest of the Australian Government in the development of the new power source was stated and the generous help received from the United Kingdom, other Commonwealth countries, and from the United States of America through Australia's bilateral agreement with that country, was acknowledged. It is intended that, within the limits of the man-power and financial resources available, the Australian project will make a maximum contribution to the development of the technology of the source of new power; care will be exercised to avoid unnecessary duplication of work going on elsewhere. Mr. Menzies said that for Australia it is the beginning of an epoch comparable with the introduction of steam and electricity. First and foremost, Lucas Heights is a research establishment, which will make Australia scientifically and technically equipped to take advantage of nuclear power. Australia, he said, aims at securing mutual arrangements for the exchange of information with Britain and the United States, and, he hoped, before long with Canada. "Nuclear energy has an unlimited future, and this future will be even greater if we can get rid of the threat of war. . . . We in Australia are lucky that whatever limits may exist on our resources, we have great supplies of coal, substantial supplies of hydro-electric power, either in existence or in the making, and we have uranium. Therefore, we can approach the problem of nuclear power scientifically, and coolly, and decide the best ways to go about taking our place in the development of nuclear power. With *HIFAR* we will be able to keep abreast of development and become scientifically equipped to take our place among the nuclear nations."

After his speech, the Prime Minister threw a switch which brought *HIFAR* up to full power of 10 MW., and the official party made a tour of the installation. During this period the guests at the opening were able to watch the proceedings on large-screen television sets which had been specially installed for the purpose. On completion of the official tour, the laboratories were thrown open and the visitors enjoyed the various demonstrations which had been especially arranged for the occasion.

E. W. Titterton

[1] Grout, H. J., and Fenning, F. W., 1955 Geneva Conference Papers *A/Conf* 8/P/42.
[2] Grout, H. J., *J. Brit. Nucl. Energy Conf.*, **1**, 35 (1956).
[3] Watson-Munro, C. N., *Aust. J. Sci.*, **19**, 133 (1957).
[4] Gregory, J. N., *Chem. Indust. and Eng.* (*Austral.*), **6**, 4, 26 (1956); **6**, 5, 24 (1956).

REPETITION OF AN EXPERIMENT ON BIRD ORIENTATION

By KLAUS HOFFMANN*

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RECENT experimental findings as well as theoretical considerations (for reviews, see refs. 1 and 2) have raised a number of serious objections to the hypothesis of Sun navigation by birds formulated by Matthews[3,4]. Striking experimental support of this hypothesis seemed to be the 'Sun occlusion' experiment. This is based on the fact that at about the equinox the declination of the Sun changes rapidly. If the Sun navigation hypothesis holds, and the birds are not able to make the corrections necessary for the seasonal changes occurring in the Sun's path without observing it, it should be possible to deceive the birds by preventing them from seeing the Sun for a number of days, and releasing them after a latitudinal displacement[3,4]. A bird, for example, which is occluded from the Sun for seven days about the autumn equinox, and then displaced 60 miles south, will experience a culmination altitude that is 3° 6·9′ less than the last seen at home, and should therefore assume a northerly displacement of 155 miles.

Matthews's own experiments made in Cambridge in 1951 and 1952 supported his assumptions. Only four out of twenty-two experimentally treated pigeons started with the controls in the home direction, while the other eighteen headed in a broad fan in the direction postulated by Matthews according to his assumptions[3]. The same experiment carried out in three subsequent years at Wilhelmshaven in Germany failed to show this result. Most of the sixty-two experimental birds headed north as well as most of the twenty-six controls, and there was no difference in homing speed between the two groups. Seven out of eight experimental pigeons reported on their way were found north of the release point[1,5,6]. It should further be mentioned that Matthews's expectation with regard to this experiment strictly applies only to the instant of noon. Birds released in the morning should steer east, those at noon south, and during the evening west. A release carried out in between these times should result in an intermediate direction (for detailed discussion, see Kramer[6]).

If one assumes that in Matthews's experiments the experimentally treated birds really headed towards an expected home and were not influenced otherwise by their confinement, irrespective of the above-mentioned adjustments of the expectation with regard to this experiment, there seem to be only two possible ways of explaining the difference between the results obtained at Cambridge and at Wilhelmshaven: (1) The German pigeons might be 'better' navigators than the bulk of the Cambridge birds, and even compensate for the seasonal changes of solar declination, an explanation already suggested by Matthews for the four birds oriented towards home in his experiment. This would mean a genetical difference between the two stocks of pigeons used. (2) In the Wilhelmshaven area the southerly direction gives the best departure diagrams and the quickest homing[1,6]. In this area a general tendency to turn north regardless of the home direction might exist, and such a tendency might mask possible Sun navigation. No such directional differences have up to now been reported from England.

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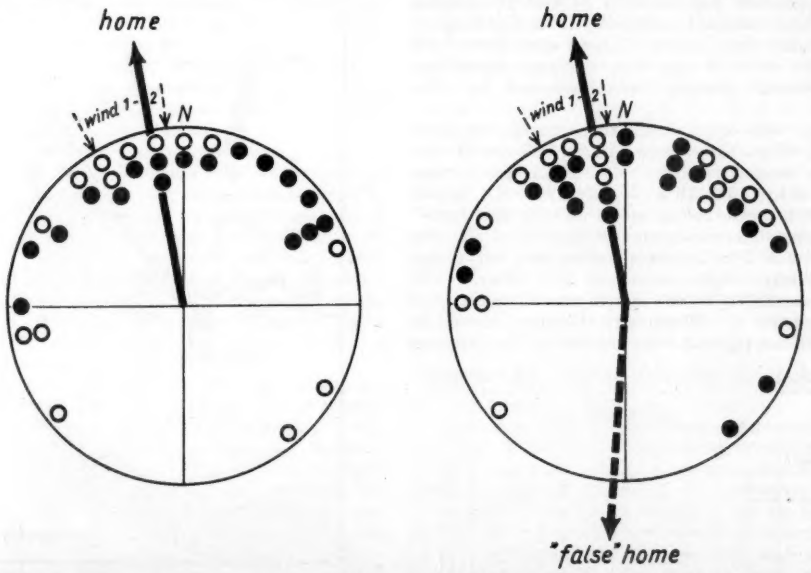

Fig. 1. Initial directions taken by individual birds after release. Left-hand diagram, control birds. Right-hand diagram, experimental birds. Open circles, English stock; black circles, German stock; solid arrow, true home direction; dotted arrow, false home direction according to Matthews's expectations. Wind in Beaufort units

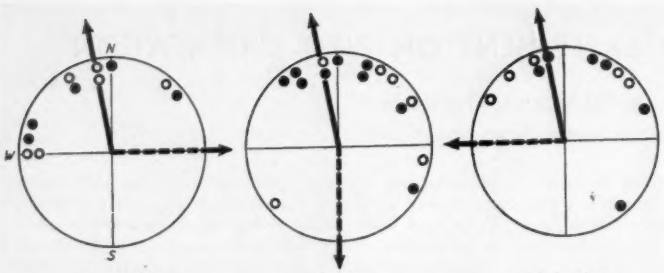

Fig. 2. Initial orientation of experimentals at: (*a*) 5½ until 2½ hr. before true local noon; (*b*) 2½ hr. before until 2½ hr. after true local noon; (*c*) 2½ until 4 hr. after true local noon. Dotted arrows, 'false' home direction according to corrected expectation of the experiment. For further explanation see Fig. 1

To clear up these questions, a stock of pigeons consanguineous with the Wilhelmshaven birds was settled at the Ornithological Field Station, Madingley, Cambridge (52° 13·5′ N., 0° 2·8′ E.), in 1955 together with thirty pigeons bought from Mr. Cope, a local fancier who had provided a great part of Matthews's birds. The two stocks were bred separately. The experiment was repeated with pigeons of both stocks in the autumn of 1957. On the evening of September 23, seventeen English and twenty-two German birds were confined to a part of the loft where the sky and even direct shadows caused by the Sun were excluded from view. Only a faint light coming from the neighbouring part of the loft was admitted, together with the noise caused by the other pigeons. Artificial light was provided from a quarter of an hour after sunrise to a quarter of an hour before sunset. Another fourteen English and nineteen German birds were confined to a similar part of the loft where, through a wide grid to the south, they had a full view of the Sun nearly all day long. These birds were used as controls. The whole procedure was essentially similar to that used by Matthews in his experiments. The age of the pigeons was between 3½ and 18 months. They had been released previously from distances of 7 and 14 miles only, most of them once from both distances in each of the four cardinal directions. Any directional training was excluded by this treatment.

The birds were kept under these conditions until October 1, when they were put in a covered van after dark, and driven to the release point near Wrotham, Kent (51° 19·3′ N., 0° 19·8′ E.), about fifteen miles from the release point used by Matthews[3]. During their confinement, the declination of the Sun had fallen by 3° 30·2′, corresponding to a fall caused by a northerly displacement of 242 miles. The actual displacement to the south was 62 miles, so a net displacement of 180 miles to the north should be simulated if the pigeons were misled by the previous treatment. The pigeons were released from the tower of a temporary television relay station which allowed a good all-round view. Experimental and control birds were released alternately. They were thrown up into the air singly and followed with 9 × 63 field-glasses until they were out of sight. The bearings of the vanishing point and the time between release and vanishing were noted. The birds were allowed to see the Sun about half a minute before being released. The weather was fine all day, with open sky and always full sight of the Sun. But it was rather hazy with a visibility of about two or three miles during the morning and evening, extending to six miles around noon. The vanishing times, therefore, were shorter than usual. It was fairly mild, a typical 'Indian Summer' day. The release lasted from 6.30 a.m. until 3.45 p.m. (G.M.T.).

Table 1. Orientation Time (from Release until Vanishing)

	Time in sight (min.) 1–2	2–3	3–4	4–5	> 5	*n*
Experimentals:						
English	3	6	5	2	1	17
German	4	9	2	5	—	20
Total	7	15	7	7	1	37
Controls:						
English	1	7	4	—	2	14
German	1	7	5	1	3	17
Total	2	14	9	1	5	31

The departure diagram of sixty-eight birds is given in Fig. 1; two experimental birds and two controls were lost prematurely. There is no indication whatsoever that either the English or German experimental birds were influenced by the treatment. Like the controls, the majority of both started in the home direction. The experimental birds flew off as directly as the controls. There is no difference in the vanishing time between the two groups (Table 1). If one considers the different directions that should result according to a stricter application of the hypothesis (see earlier), again no tendency to start in the direction predicted by the Sun navigation hypothesis can be detected (Fig. 2).

Homing was rather slow. Only three experimentals (one English, two German) and two controls (two

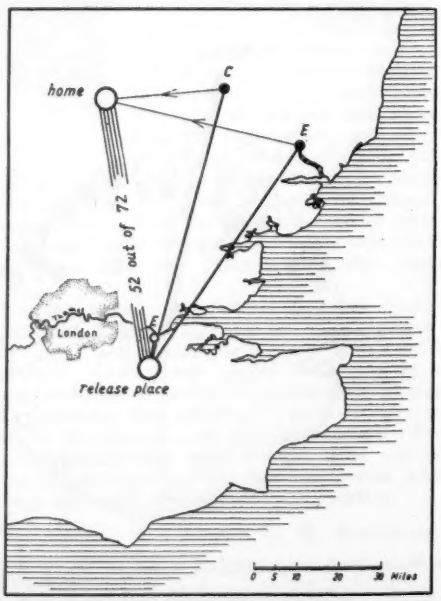

Fig. 3. Map showing reports-on-the-way of two experimentals (*E*) and one control (*C*). Open circle, English stock; black circle, German stock

Table 2. TIMES FOR RETURN

	Homing time < 24 hr.	24–72 hr.	later*	lost	n
Experimentals : English	6	2	3	6	17
German	3	4	10	5	22
Total	9	6	13	11	39
Controls : English	7	2	2	3	14
German	5	2	6	6	19
Total	12	4	8	9	33

* Until October 15.

English) reached their loft on the release day. Table 2 gives the overall homing result. The slight difference between experimental and control birds is far from being significant. Two experimentals and one control were reported on their way, all well north of the release point (Fig. 3). Two of them were released again, and homed immediately.

Again no influence of the Sun occlusion treatment could be detected in this experiment, although the possibility of genetical or geographical differences which might have accounted for the different results obtained at Cambridge and at Wilhelmshaven seems highly remote here. This result does not support the Sun navigation hypothesis.

I gratefully acknowledge the constant help and encouragement that I received in the preparation of this experiment from Dr. W. H. Thorpe and Dr. R. A. Hinde. Mr. E. Wilson gave invaluable help in technical preparations; further, I thank Miss E. M. Barraud and Miss P. Pilcher for checking the incoming pigeons. I am indebted to Mme. A. Fiel for correcting the English of the manuscript. The necessary funds were provided partly by a grant made to Dr. W. H. Thorpe by the Royal Society, partly by the Deutsche Forschungsgemeinschaft, and by a special grant from the Max-Planck-Gesellschaft.

[1] Kramer, G., *Ibis*, **99**, 196 (1957).
[2] Kramer, G., in "The Biology of Birds" (Academic Press, New York) (in the press).
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[4] Matthews, G. V. T., "Bird Navigation" (Cambridge, 1955).
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FLUORESCENT WHITENING AGENTS

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FLUORESCENT or optical whitening agents or, as they are often incorrectly called, fluorescent bleaching agents, are now widely used for improving the whiteness of textile fabrics and of paper. An application in particular which can barely escape notice is that they are added to almost all the proprietary domestic washing agents currently marketed. These agents possess the property of absorbing, preferentially, ultra-violet light in the wave-length region of 350 mμ followed by re-radiation of a proportion of the absorbed energy in the form of visible light which is violet, blue or greenish in colour, falling mainly in the range of wave-lengths 400–500 mμ with maximum emission at 430–450 mμ.

The application of a fluorescent whitening agent to an off-white fabric has two effects upon its appearance as observed in daylight or other illuminant containing an appreciable amount of light of wave-length about 350 mμ. The colour becomes bluer and the brightness (or luminance) increases; moreover, any deficiency of blue in the reflected light which would otherwise cause the fabric to appear yellow is made up by the added blue light with the production of nearly white light. These factors combine to give the fabric a whiter and brighter appearance.

This behaviour may be compared with the process of 'blueing' with a dye or pigment, an operation which has been common practice in the textile finishing and laundry trades, and in domestic laundry work, from time immemorial. The blue dye simply absorbs the yellow light which would otherwise be reflected from the sample, thus decreasing the luminance, and any yellow tint is changed to a pale bluish-grey which is less objectionable to the eye. The net result in this case is that less energy, instead of more, is being radiated in the visible region than would be the case with the untreated fabric.

Clearly, there is an optimum quantity of any given fluorescent whitening agent for achieving the best white with a particular fabric. If this amount is exceeded, the colour of the fluorescence will become apparent and the fabric will appear violet, blue or green according to the type of agent used. The addition is not so critical as this might suggest, however, since the human eye is remarkably accommodating and the colour it sees is strongly dependent on circumstances. Thus, a sample of fabric may appear of a satisfactory whiteness until it is compared with another sample that has been treated with an optical whitening agent; it will then appear yellow. Alternatively, the fluorescent sample may appear excessively blue until it is compared with another sample containing much more agent, when it may appear pure white or even slightly yellow.

It is important to note that the appearance of fabrics containing a fluorescent whitening agent is particularly sensitive to the nature of the illuminant. The presence of the agent will not improve the appearance of a fabric viewed under a source of illumination that is deficient in ultra-violet, for example, a tungsten filament lamp. On the other hand, the appearance under light from a fluorescent 'daylight' lamp, which contains an appreciable amount of ultra-violet, is noticeably enhanced.

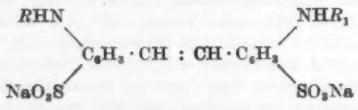
The property of fluorescence is, of course, possessed by many common materials, for example, anthracene, mineral oils and even human skin and finger nails. Other important properties are necessary, however, in an optical whitening agent for use on textiles. It should not be readily destroyed or discoloured by light or by the assistants commonly used in laundering, it should be without effect on dyes, non-dermatitic, non-corrosive towards the plant employed in finishing and laundering, and it should have the

property of substantivity, that is, the ability to attach itself to textile fibres so that it is not easily removed by washing. Fluorescent agents intended for use in textile finishing operations, where a single carefully controlled application is the rule, should have a high degree of substantivity and it may be desirable that they should be stable in the presence of bleaching agents such as alkaline sodium hypochlorite, hydrogen peroxide or acidified sodium chlorite. With products intended for use in laundry preparations a high degree of substantivity is less desirable, for although this makes for economy in use it may lead to the accumulation on garments of amounts far exceeding the optimum, with consequent deterioration in quality of whiteness.

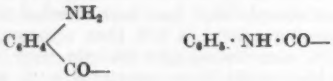
A detailed discussion of the chemistry of optical whitening agents is outside the scope of the present article. Most of the published information is contained in patents, but a few reviews have appeared[1–4]. The attempts of manufacturers to secure optimum combinations of properties for different applications (for example, to take account of the different behaviour of the various fibres, natural and man-made) have led to the synthesis of hundreds of compounds which are claimed to be suitable. About fifty products, some of which may be chemically very similar, or even identical, are commercially available in Great Britain at present.

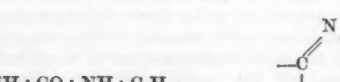
The first fluorescent compound to be marketed as a whitening agent was the acetate of β-umbelliferone. The compounds currently used are, in the main, derivatives of one of the following: stilbene, mainly 4 : 4′ diamino stilbene 2 : 2′ disulphonic acid; benzthiazole; benzimidazole; dibenzimidazole; coumarin.

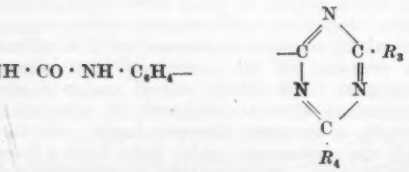
The stilbene derivatives have in general the formula:



The groups R and R_1 have an important effect upon such properties as light stability and substantivity. They may be of many types, for example:



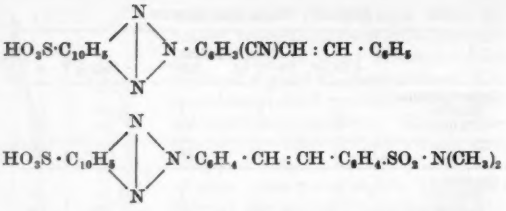




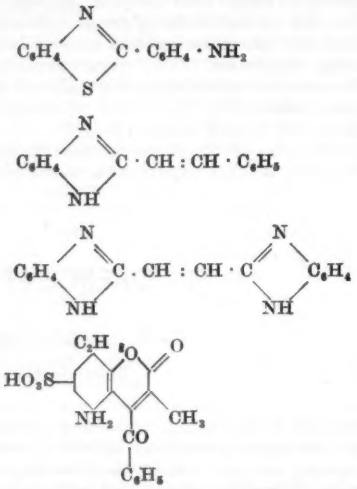
The series of triazyl derivatives last mentioned is perhaps the most important class of substituents. The groups R_3 and R_4 may be chosen from a numerous and varied selection, including the following:

—OH, —$CH_2 \cdot CH_2 \cdot OH$, —$N(CH_2 \cdot CH_2 \cdot OH)_2$, aminopyridyl.

Two stilbene compounds not derived from diamino stilbene disulphonic acid have been suggested recently for cellulosic textiles and for nylon:



The following compounds are examples of benzthiazole, benzimidazole, dibenzimidazole and coumarin derivatives which have been put forward as fluorescent whitening agents:



In order to be able to compare the efficiency of different fluorescent whitening agents, and to determine their stability and permanence on fabrics or other materials, some method of measuring the brightening effect is required. Although this may be judged visually in practice, visual assessment is not adequate for investigational work.

The methods employed vary with the purpose of the investigation. If it is merely desired to measure the amount of any particular agent present in order to determine its resistance to removal by laundering or its destruction by exposure to light, it is only necessary to illuminate the sample with ultra-violet light of given intensity and around 350 mμ in wave-length and to measure the intensity of the emitted visible light, after filtering out any reflected ultra-violet component, by means of a photocell.

If, on the other hand, it is desired to compare the whitening effects of different agents which may have differently coloured fluorescences, the problem is much more complex. The first difficulty lies in the selection of a suitable illuminant. Ideally, the illuminant should have a spectral energy distribution equivalent to that of daylight, in the ultra-violet as well as the visible region; but no standard illuminant of this type exists. The ultra-violet content of daylight is in fact somewhat variable and the selection of a typical value is not an easy matter. The means of providing a standard source is under consideration and it is possible that one will be available shortly; for example, it may take the form of a xenon arc. When such a source is available, a tristimulus colorimeter could be used in the ordinary way. An alterna-

tive method, involving computation, would be to use a tristimulus colorimeter separately with Illuminant *C* and with an ultra-violet source, afterwards combining the readings to predict the tristimulus coefficients that would be obtained with the ideal illuminant. The interpretation of these results is complicated by the fact that the eye is willing to accept a change in chromaticity towards blue and an increase in luminance as being equally satisfying. It has been found experimentally, in the comparison of green-shade and violet-shade whiteners, that the former have a greater lightening effect and the latter a greater blueing effect, and that these two effects can be comparable perceptually[5].

One of the disadvantages which may attend the use of optical whitening agents, namely, poor stability of the white due to the poor fastness to light of most of these agents, has already been mentioned. If, for example, articles so treated are exposed in a shop window, the parts receiving most light might become appreciably yellower in shade than the other parts. Poor fastness to light is not of much significance in laundering. Here the greater danger is that of excessive build-up of the agent in successive washes with the resultant formation of an objectionable tint; careful choice of the fluorescent agent is necessary to avoid this.

Some fluorescent agents are known to cause a yellowish discoloration, particularly with wool, after a comparatively short exposure to light and, in consequence, a dyer may be accused unjustly of using dyes of poor light-fastness when the fault really lies with the optical whitening agent employed in laundering. Quite apart from fading, or the development of an objectionable tint on exposure to light, there is an additional hazard; some of the agents available can cause the development of a pink or green shade on storage, even in the dark.

It will be seen, therefore, that the widespread use of fluorescent whitening agents has not proved to be an entirely unmixed blessing. Their introduction has brought in its wake serious new problems for the dyer and additional hazards for the retailer and consumer. No doubt many of the difficulties that have already arisen have been due to misuse of the agents, but it is already abundantly clear that this particular incursion of science into textile technology will have to be brought under careful control. In particular, it cannot be too strongly emphasized that the use of these agents cannot in any way be regarded as a substitute for the removal of natural colouring matter by conventional bleaching methods.

Fluorescent brightening agents was the subject of a meeting of the West Riding Section of the Society of Dyers and Colourists, held at Bradford on March 13.

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THE GLASGOW MEETING OF THE BRITISH ASSOCIATION

THE British Association for the Advancement of Science will hold its annual meeting this year in Glasgow during August 27–September 3. The Association is too well known to readers of *Nature* to require introduction: suffice it to say that the City and University of Glasgow are very pleased to welcome its return after an absence of thirty years, and to place at the disposal of its members the greatly increased facilities for the furtherance of scientific and technological studies which have been built up in the intervening period. Such of the members as recall the meeting in 1928 will see much visible evidence of the advances of science since their last visit.

The general pattern of events in Glasgow will be similar to that of the Association's meetings at other centres in recent years. The mornings will be devoted to lectures and discussions for which the members attending will divide into their various groups and sub-groups. The afternoons will be largely given over to excursions and educational visits, and the evenings to social functions. For all these purposes, most of the available space in the University has been requisitioned. An outline of the topics proposed for the morning sessions is given in the preliminary programme of the meeting (obtainable from the Secretary, British Association for the Advancement of Science, Burlington House, London, W.1).

The Glasgow meeting will have one important advantage over those of recent years, in that the University site on Gilmorehill is compact and members will have little difficulty either in finding their way there or, when there, in locating the lecture theatres or other meeting rooms. Catering will, likewise, be simplified, as the Unions and the adjacent College of Domestic Science have generously put their facilities at the Association's disposal. Plans have been made for providing a mid-day meal for the 3,000 or so visitors who are expected to attend the meeting, and for the supply of mid-morning coffee.

The preliminary programme referred to above also gives details of the excursions and visits offered to members by the Local Committee. These are many and varied and cater for all interests, perhaps especially for the geologists, geographers and engineers who, in view of Glasgow's situation and character, are most likely to find the 1958 meeting a memorable one. A well-chosen series of excursions will cover most of the important aspects of the geology and geography of the west and south of Scotland. On the engineering side, a wide range of visits to industrial premises and research stations has been planned, by courtesy of the firms and Government departments concerned. Both heavy and light industry will be represented. In addition to those excursions and visits which are more or less clearly linked to some aspect of science or its applications, facilities will be offered for visits to local beauty spots, including Loch Lomond, the Trossachs, Arran and the Firth of Clyde.

The meeting will provide an occasion for a number of exhibitions of scientific interest, by the scientific societies of Glasgow and district, the Geological Society of Glasgow (which celebrates—most appropriately—the centenary of its foundation this year) and others. The oil companies will mount a major exhibition, "Geology in the Petroleum Industry", in

the Royal College of Science and Technology. Of interest to schoolchildren and their parents will be an exhibition, "Science in Schools", arranged by the local officers of the Science Masters' Association.

A novel feature of the 1958 meeting will be a series of lecture-demonstrations for school-children given by eminent scientists. The publicity given to this innovation, coinciding as it did with a local school-children's exhibition and the British Association's own recent conference on "Science in Schools", may have created the impression locally that the Association's interests are turning exclusively to the advancement of science among school-children. There is no doubt, however, that it has given a welcome fillip to the publicity campaign undertaken by the Local Committee on the Association's behalf, and that the progress of the 'Junior British Association', as it has come to be known, will be followed with much interest.

The Local Committee has not neglected the lighter side. A dinner or similar function is planned for each section of the Association, while a large-scale reception for the members will be given by the Corporation in the City Chambers and in the Art Gallery and Museum, Kelvingrove. Other social functions will include a reception arranged by the British Council for overseas guests, and a reception promoted by the scientific societies of Glasgow and district for visitors sharing their interests. On the evening of Sunday, August 31, a symphony concert will be given by the B.B.C. Scottish Orchestra in St. Andrew's Hall.

The Association meets in Glasgow under the presidency of Sir Alexander Fleck, chairman of Imperial Chemical Industries, Ltd., and himself a distinguished graduate of the University. He will address the inaugural meeting of the Association in St. Andrew's Hall on August 27 on "Science and Business: a Balanced Partnership".

OBITUARIES

Prof. Charles F. Brooks

The world of meteorology suffered a grievous loss in the death of Charles Franklin Brooks on January 8. Prof. Brooks will be remembered for his long tenure as director of the Blue Hill Meteorological Observatory of Harvard University and for his many contributions to climatology, synoptic meteorology and methods of observation. His services with several commissions of the World Meteorological Organization and its predecessor, the International Meteorological Organization, made him a rather frequent visitor to Great Britain and the Continent. Most recently he served on the committee that produced the new International Cloud Atlas.

Prof. Brooks was born on May 2, 1891, in St. Paul, Minnesota. He was educated at Harvard University, which awarded him the A.B. in 1911, the A.M. in 1912 and the Ph.D. in climatology in 1914. While still a student at Harvard he served as an assistant at Blue Hill, thus becoming familiar with the Observatory where he was later to spend much of his professional career. After four years in the U.S. Department of Agriculture and as an instructor in geography at Yale University, Prof. Brooks began his meteorological career in the U.S. Weather Bureau, where for two years he was editor of the *Monthly Weather Review*. In 1921, he was appointed associate professor (later professor) of meteorology and climatology at Clark University, Worcester, Massachusetts. In 1931, he assumed the post of professor of meteorology and director of the Blue Hill Meteorological Observatory at Harvard. He remained at Blue Hill until his retirement a few months before his death.

Prof. Brooks played a leading part in the establishment of the American Meteorological Society in 1919. He served the Society with untiring devotion as its secretary from its inception until 1954, editor of its *Bulletin* for seventeen years and as treasurer in 1922. Through the lean years of the 'twenties and the early 'thirties Prof. Brooks almost single-handedly kept the Society alive. Fortunately, he lived to see the Society become the largest and most active meteorological society in the world. He was a member of many other societies, including the Royal Meteorological Society, and served as president of the Association of American Geographers in 1947.

Those of us who knew Prof. Brooks will remember him most for his warmth, kindness and humanity. Throughout his life he gave freely of his time and resources to the many who sought his assistance. Many American meteorologists were guided and assisted early in their careers by him. His charitable acts extended far beyond the realms of meteorology, and there is little doubt that his concern for his fellow-men acted as a detriment to his own scientific activities.

Prof. Brooks was one of our most effective spokesmen to the general public. He ably presented the case for meteorology and meteorologists through radio broadcasts, the Press, many talks and his book, "Why the Weather". He also kept his representatives in the United States Congress informed on pending legislation that involved meteorological questions. He was a staunch and effective supporter of the United States Weather Bureau.

We will sorely miss our friendly colleague in the years to come, but his influence will continue through his many good works and the example he set for his legion of friends. Henry G. Houghton

Mr. Arthur Earland

Mr. Arthur Earland died on March 27 at Broughty Ferry, Dundee, at the age of ninety-one. Internationally known in the field of marine zoology, in particular for his contributions to our knowledge of the Foraminifera, he was by profession a Civil servant and employed in the Post Office Savings Bank Department. By all standards he was successful in both his professional and amateur ventures, and his name is a worthy addition to any list of eminent amateur naturalists of the past.

He was born at Lewisham on November 3, 1866, and received his only formal education at a local school. He declined a university education, feeling this would lead him to school-teaching as a career, and entered the Civil Service in 1885 as a 'boy clerk'. Here he stayed in various capacities until 1926, when ill-health caused his premature retirement. He had then been three years as an assistant controller, and during his service he was the person chiefly responsible for drafting the Stock Register Regulations, as well

as being organizer of War Stocks during the First World War.

In the absence of any special training, Earland's interest in science was stimulated in about 1887 through the acquisition of a microscope and a copy of M. C. Cooke's "One Thousand Objects for the Microscope". Later he joined the Quekett Microscopical Club, where he met Halkyard, who encouraged him to start working with Foraminifera. Further encouragement from Millet, Joseph Wright, Lister and D'Arcy Thompson ensured Earland's place in the study of marine zoology of the day. By 1891 he had published his first work, a paper on the Recent Foraminifera of Malta, and thereafter appeared many papers until his last which appeared in 1957. All were symbolic of a painstaking and accurate man, and several of them remain as classics of their type.

Earland was an active member of many scientific societies and at one time he was vice-president of the Royal Microscopical Society, of which he became an honorary Fellow in 1951. In 1938 and 1939 he was president of the Hertfordshire Natural History Society, and in 1942 he was elected a Fellow of the Royal Society of Edinburgh.

No mention of Earland would be complete without reference to his twenty-five-year partnership with Edward Heron-Allen during 1907–32. This resulted in a stream of first-rate papers and monographs, beautifully illustrated, on the Recent Foraminifera of various areas around the British coasts, and of other parts of the world. The most important of the latter were those of the Kerimba Archipelago, Portuguese East Africa (published in 1914–15), the British Antarctic (*Terra Nova*) Expedition (published in 1922), and of the Discovery Expeditions (four reports published in 1932, 1933, 1934 and 1936, the last three by Earland alone).

Earland, to use his own words, had a "contempt for regulations, precedents and authorities"; and in the words of others was the "most sympathetic and the most helpful of chiefs, and one whose keen interest and untiring industry were infectious".

R. H. Hedley

NEWS and VIEWS

The Third Russian Earth Satellite (1958 δ)

The launching of *Sputnik* 3 (Satellite 1958 δ) was announced from Moscow on May 15. The satellite was stated to be conical in shape, with a length of 12·3 ft. excluding aerials, a base diameter of 5·7 ft. and a weight of 2,926 lb., including 2,134 lb. of apparatus. The experiments for which the satellite is designed include studies of cosmic rays, geomagnetism, solar radiation and micrometeorites, and the results are to be telemetered back to the Earth. The satellite is equipped with solar batteries and carries a radio transmitter with a frequency of 20·005 Mc./sec. There are two other objects in orbit with the satellite, namely, the rocket which performed the last stage of propulsion and a nose cone which protected the instruments during the climb through the atmosphere.

According to the Royal Aircraft Establishment, Farnborough, the radio signals are much weaker than those from the first two Russian Earth satellites, and because of their low frequency are too much affected by the ionosphere to be entirely satisfactory for determining the orbit. Furthermore, the orientation of the orbital plane is such that the satellite is not likely to be observed visually from Britain until late in June. At present the orbital elements are not accurately known. The inclination of the orbit to the equator is near 65°, as for *Sputniks* 1 and 2. The period of revolution at noon on May 16 was 106·0 min. It seems likely that the height of *Sputnik* 3 at perigee is not very different from that of its predecessors, that is, roughly 220 km., and that the position of perigee is near latitude 50° N. when the satellite is going north-east. The apogee height is about 2,000 km., the eccentricity being about 0·12. The orbital plane is rotating about the Earth's axis from east to west at a rate of 2·5° a day, and it is to be expected that perigee will move backwards along the orbit at a rate of rather less than ½° a day. The first rough estimate of life-time is one year, but this is subject to considerable error.

Tracking the Russian Earth Satellite

Within an hour of receiving the news that the third Russian artificial Earth satellite had been launched, measurements were being made on its signals at the Radio Research Station (Department of Scientific and Industrial Research) at Slough. A graph showing observations of the radio bearing of the satellite on its fourth orbit during its passage over Britain soon after noon on Thursday, May 15, was included in the exhibits at the Royal Society's conversazione the same evening. Among later measurements more precise track information was obtained some twenty-four hours later (orbit number 17) when, at its nearest approach, the satellite was at an angle of elevation of about 60° on an azimuthal bearing of 135° true. During this particular transit the maximum rate of change of bearing reached 3° a second, as recorded from observations made at intervals of about five seconds. In addition, the Doppler change in frequency of the signals transmitted by the satellite is being measured and recorded, so that a more complete study can be made of the orbit being followed. Preliminary results have already been communicated to other interested establishments in Britain.

Virology at Glasgow : Prof. M. G. P. Stoker

Dr. M. G. P. Stoker is to be the first holder of the newly established chair of virology in the University of Glasgow. This appointment is significantly opportune at the present time, when technical advances in virology are contributing on an ever-increasing scale to emphasize the importance of intracellular parasites as initiators of disease. Dr. Stoker will take with him to Glasgow an exceptionally wide experience of research into viral and rickettsial maladies. Educated at Oakham School and Sidney Sussex College, Cambridge, Stoker obtained his clinical training at St. Thomas's Hospital, London, and took the M.B., B.Chir., of Cambridge in 1942. He was actively concerned in

research on typhus in India, while serving in the R.A.M.C. during the War. Soon after demobilization, he was appointed demonstrator in pathology at Cambridge. His thesis on "Rickettsial Diseases in India", for the degree of M.D., was awarded the Raymond Horton Smith Prize in 1947. Stoker was elected a Fellow of Clare College in 1948, later becoming director of medical studies and assistant tutor of his College. Since 1951 he has been the Huddersfield lecturer in special pathology; he has also served as secretary of the Faculty Board of Medicine of the University of Cambridge.

Stoker has combined outstanding success in college duties and administration with the ability to prosecute and direct an exceptionally full programme of research. With Dr. B. P. Marmion he opened up a new facet in British medicine by establishing the existence and prevalence in Britain of *Q* fever caused by *Rickettsia burneti*. More recently, his studies have concentrated on the growth of viruses in cellular cultures. In 1956 he delivered the Lock Lecture before the Royal Faculty of Physicians and Surgeons of Glasgow, indicating in a particularly lucid manner the importance of latent viral infection in man and animals. His experience as a popular college tutor should serve him well in his new academic surroundings, and as a keen yachtsman he will be entirely at home on the Clyde.

Ministry of Supply: Advisory Council on Scientific Research and Technical Development

Prof. J. L. M. Morrison, professor of mechanical engineering in the University of Bristol, has been appointed chairman of the Ministry of Supply's Advisory Council on Scientific Research and Technical Development in succession to Sir Eric Rideal, who has been chairman since 1953.

The following new members of the Council have been appointed: Sir William Cook, member of the board of the Atomic Energy Authority for engineering production; Sir Ian Heilbron, lately director of the Brewing Industry Research Foundation; Prof. W. T. J. Morgan, deputy director of the Lister Institute and professor of biochemistry, University of London; Prof. N. F. Mott, Cavendish professor of experimental physics, University of Cambridge; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool.

Atomic Safety Committee

Sir Douglas Veale, until recently registrar at the University of Oxford, has been appointed chairman of a committee set up by the United Kingdom Atomic Energy Authority to advise on training in radiological protection. The committee includes Sir Ernest Rock Carling, consultant adviser to the Ministry of Health, the Atomic Energy Authority and the Home Office; Prof. W. V. Mayneord, director of the Department of Physics, Institute of Cancer Research, Royal Marsden Hospital; and Prof. B. W. Windeyer, professor of radiology (therapeutic), University of London. This committee will advise the Authority on the training and provision of specialist health and safety staff, not only for the Authority's own purposes but also to meet the needs of the nation as a whole. The report of Sir Alexander Fleck's Health and Safety Committee which was published in December (Cmnd. 342) considered that the Authority should assume responsibility for building up the supply of the specialist health and safety staff required as the uses of atomic energy become more wide-spread. Immediate steps have been taken to build up the Authority staff, and recruitment is in progress.

Centenary of Convocation in the University of London

The government of the University of London is vested in the Senate, the Court and Convocation, the latter comprising the Chancellor and Vice-Chancellor, and duly enrolled graduates of the University. The statutory functions of Convocation include the election of the Chancellor, whenever a vacancy in that office occurs, the election of seventeen members of the Senate distributed over the eight faculties, and the right to discuss any matter relating to the University and declare its opinion thereon to the Court or to the Senate. At the centenary meeting of Convocation held in Senate House on May 13, the chairman, Dr. P. Dunsheath, delivered a lecture which has since been published ("Convocation in the University of London: Centenary Lecture 1958". Pp. 16. London: The University, 1958), in which he traced the history of Convocation from its origins in the graduates' committee which first met in 1848. Convocation several times advocated the institution of new degrees, including those of music and engineering, but its greatest single contribution to the progress and reputation of the University was through its support for the admission of women, resulting in the Supplemental Charter of 1878. Dr. Dunsheath and Mrs. Margaret Miller have recently written a full history of Convocation ("Convocation in the University of London: The First Hundred Years". Athlone Press, 1958. 15*s*.) with a foreword by the Chancellor, H.M. Queen Elizabeth The Queen Mother.

Leverhulme Research Awards, 1958

Among the research fellowships and grants awarded by the Leverhulme Trust are the following: *Fellowships:* Dr. T. Barnard, reader in micropalæontology, University College, London, for a study of the microfossils from the upper chalk of East Anglia; G. G. Hopkinson, senior history master, Swanwick Grammar School, Derbyshire, for a study of the lead, coal and iron industries in Derbyshire and the West Riding, 1500–1850; Dr. P. A. H. Wyatt, lecturer in chemistry, University of Sheffield, for a study of the constitution of concentrated electrolytic solutions. *Grants:* J. M. Allegro, assistant lecturer in comparative Semitic philology, University of Manchester, to continue the preparation of the Dead Sea Scroll fragments for publication; J. M. Cook, reader in classical archæology, University of Bristol, to complete an investigation of ancient Greek settlements in western Asia Minor; E. F. Gilmour, director, Museum and Art Gallery, Doncaster, for a study of the Prioninæ of the Belgian Congo; Miss M. R. Haswell, Department of Agriculture, University of Reading, for a study of the development from simple subsistence to cash economies in under-developed countries; A. MacLennan, director, Training College for Technical Teachers, Huddersfield, to study the correlation between works training and technical college teaching for engineering craft and technician apprentices; Dr. R. B. Pike, principal scientific officer, Marine Station, Millport, and Dr. D. I. Williamson, naturalist, Marine Biological Station, Port Erin, to study the larval development of hermit crabs of the diogenid group occurring in the Bay of

Naples; Dr. K. Schofield, reader in organic chemistry, University of Exeter, for a study of the techniques of nucleic acid chemistry; Prof. F. C. Thompson, professor of metallurgy, University of Manchester, for a metallurgical investigation of the techniques of production of ancient coins; and M. J. Webb, lecturer in geography, University of Oxford, for a study of weather and rainfall in India. Further information about the awards can be obtained from the Secretary, Leverhulme Research Awards, St. Bridget's House, Bridewell Place, London, E.C.4.

Portsmouth College of Technology: Golden Jubilee Research Fund

THE City of Portsmouth College of Technology, which was accorded regional college status by the Ministry of Education last year, has almost doubled in size in the past five years, now having more than seven thousand students, of whom more than nine hundred are full-time and sandwich course students and some are research workers. It serves, through its advanced courses in science and technology, the whole of the Southern Region consisting of the counties of Hampshire, the Isle of Wight, Dorset, West Sussex, Wiltshire, Berkshire and Oxfordshire. Portsmouth Education Authority has given generous support in helping to solve problems arising from these developments, but even so, considerable strain has recently been imposed on College finances, especially in the field of research. The College this year celebrates its golden jubilee with an open day, to be held on May 30, and in this connexion is putting forward an appeal for subscriptions towards a research fund. The College believes that if it is adequately to perform its function of educating and training the scientists and technologists of the future, there is an ever-increasing need for close association between industry and the college, particularly in research and consultative work. The existing association, already strengthened through the formation of advisory committees, would, it is felt, be further reinforced by the establishment of a research fund in this way. Contributions to the fund and any requests for further information should be addressed to the Registrar, City of Portsmouth College of Technology.

Scientific Literature concerning Fire

THE Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization issue a comprehensive bibliography of references to scientific literature on fire. Part 8 (References to Scientific Literature on Fire, Part 8, 1954. By Miss E. M. Shakeshaft and Mrs. B. F. W. Rogowski. Pp. 126. (Library Bibliography No. 5/Part 8. Boreham Wood, Herts: Fire Research Station, 1958) contains 1,242 entries arranged under seven heads: occurrence of fire; fire hazards; initiation and development of combustion; fire precautions; fire-resistance; fire-fighting; and general. There are also an author index and an alphabetical subject index.

Arid Zone Research

THE Unesco publication "Climatology—Reviews of Research", No. 10 in the series "Arid Zone Research" (Pp. 190. Paris: Unesco; London: H.M. Stationery Office, 1958. 5 dollars) presents valuable reviews of present knowledge of a number of climatological and bioclimatological subjects, commissioned for the symposium on arid zone climatology held at Canberra in 1956. The reviews deal with evaporation and the water balance; climatic factors in animal ecology; radiation and thermal balance; climates and vegetation; effects of climate on man and animals and their modification by clothing and shelter; modification of microclimates by vegetation, shelter belts, alteration of radiating surface, irrigation, etc.; chemical climate and saline soils in the arid zone—mainly a review of the distribution of chlorides and sulphur; climatological observational requirements in arid zones. They are all very thorough and valuable reviews with large bibliographies, but more account should have been taken of the extensive work in these subjects carried out in recent years in the U.S.S.R. Only one of the reviews—on modification of microclimates—refers to Soviet work and then only briefly and almost entirely from abstracts published by the American Meteorological Society.

Use of Fluorescent Lighting for Experiments on Photoperiodism

FLUORESCENT lamps are frequently used as the source of illumination in the investigation of photoperiodic effects in plants and animals. Since such responses are often elicited by extremely low intensities of illumination, great care is taken to ensure that experimental chambers are completely lightproof. Drs. J. W. L. Beament and A. D. Lees (Agricultural Research Council Unit of Insect Physiology, Department of Zoology, Cambridge) write: "During routine examination of a cabinet equipped with five 40-watt 'daylight' fluorescent tubes, controlled through a conventional single-pole time-switch, a flickering white light was observed in each tube with the dark-adapted eye, even though the clock mains switch was 'off'. It was found that the time-switch was operating in the neutral side of the mains supply, and that the trouble was completely eliminated by switching in the live side. The ability of a fluorescent tube to show a gas-discharge glow when merely capacitatively coupled to an a.c. mains supply, although well known to electrical engineers and others, is certainly not sufficiently familiar to biological workers, and may possibly interfere with some types of experiment".

Colloquium Ampère, 1957

A REPORT of the proceedings of the Sixth Colloquium Ampère, which was held at St. Malo during April 24–26, 1957, appeared in *Nature* (179, 1343; 1957). The texts of the seventy-three contributions presented have since been published in the special number of Vol. 10 of the *Archives des Sciences*. Twelve different nationalities are represented, and more than a hundred research workers took part in the meeting. The subjects discussed included dielectrics; rotatory polarization; paramagnetic, nuclear magnetic and quadripolar resonance; the ammonia maser and the Overhauser effect. All the articles are very brief, and the absence of general survey talks such as have been given at previous colloquia is to be regretted.

British Agricultural History Society: Officers

AT the annual general meeting of the British Agricultural History Society, held at the Yorkshire (West Riding) Institute of Agriculture at Askham Bryan on April 11, the following officers were re-elected for the year 1958–59: *President*, Sir James Scott Watson; *Treasurer*, Prof. E. Thomas (Reading);

Secretary, Mr. J. W. Y. Higgs (Department of Agriculture, University of Oxford). Mr. Alexander Hay, Mr. M. W. Beresford and Mr. G. E. Fussell were elected to vacancies on the Executive Committee. Mr. George Ordish was re-appointed executive chairman at a later meeting of the Executive Committee. The Society's journal, *The Agricultural History Review*, has now become a recognized medium for the publication of original papers on branches of the history of agriculture, and the Society is in a sound financial position. A further substantial addition to the number of members would make it possible to add to the progress already made since the Society's foundation.

Meeting of Nobel Prize-Winners in Lindau

The annual conference of Nobel Prize-Winners at Lindau, Lake Constance, will be held during June 30–July 4 and will be devoted to various aspects of chemistry. The following addresses will be delivered: Prof. A. W. K. Tiselius (Upsala), "Die Nobelstiftung, ihre Tradition und ihr Wirken"; Prof. Adolf Butenandt (Münich), "Das Leben als Gegenstand chemischer Forschung"; Prof. Hans von Euler-Chelpin (Stockholm), "Chemische Struktur und biochemische Wirkungen"; Prof. Georg von Hevesy (Stockholm), "Radioaktive Markierung von Zellen"; Prof. Paul Karrer (Zurich), "Neuere Forschungsergebnisse über das Pfeilgift Curare"; Prof. F. Joliot-Curie (Paris), "Das neue Forschungszentrum für Grundlagen der Kernphysik in Orsay und die Ausbildung der Forscher"; Prof. Ludwig Ruzicka (Zurich), "Zur Biogenese organischer Naturverbindungen"; Prof. R. L. M. Synge (Rowett Research Institute, Bucksburn), "Natural Peptides and their Biological Significance"; Sir Alexander Todd (Cambridge), "Some Observations on Nucleotide Coenzymes"; Prof. A. I. Virtanen (Helsinki), "Antimikrobielle Substanzen in Kulturpflanzen und deren Bedeutung für die Widerstandfahigkeit der Pflanzen und für die Ernährung der Haustiere und des Menschen"; Prof. R. Kuhn (Heidelberg), "Über die Amadori-Verbindungen". A comprehensive programme of excursions has also been arranged. Further details can be obtained from the Ständiger Arbeitsausschuss für die Tagungen der Nobelpreisträger, Lindau im Bodensee, Postfach 11.

Announcements

Dr. D. H. Black, director-general of electronics research and development, Ministry of Supply, has been appointed director of the Armament Research and Development Establishment at Fort Halstead, in succession to Mr. Ewen M'Ewen, who has left the public service to take a post in industry.

Mr. Patrick Duncan McTaggart-Cowan, assistant director of the Meteorological Branch of the Canadian Department of Transport, has been appointed associate director with Andrew Thomson, Dominion Meteorologist and director of the Branch. Mr. McTaggart-Cowan, who graduated from the University of British Columbia with first-class honours in mathematics and physics in 1933 and then proceeded to the University of Oxford with a Rhodes scholarship, joined the Canadian Meteorological Service in 1936.

The Academy of Sciences, Paris, recently created a French National Committee of Biochemistry to represent France in connexion with the International Union of Biochemistry. The following officers have been appointed: *Honorary President*, G. Bertrand; *President*, R. Fabre; *Vice-Presidents*, M. Lemoigne, Prof. J. Roche, R. Bernier; *Secretary General*, Prof. J. E. Courtois (4 Avenue de l'Observatoire, Paris 6e); *Assistant Secretary*, Prof. Y. Raoul; *Treasurer*, Dr. R. Midy.

The following have been elected to Beit Fellowships for Scientific Research, of the value of £600 per annum, at the Imperial College of Science and Technology, London: Mr. F. J. J. Clarke, for research on peripheral vision under Prof. W. D. Wright (technical optics); Mr. D. G. Watts, for research in the field of control technology under Prof. A. Tustin (heavy electrical engineering).

The first members' day of the National Vegetable Research Station Association will be held on June 12. Further information can be obtained from the Secretary, National Vegetable Research Station Association, Wellesbourne, Warwick.

An international Congress of Radiation Research will be held at the University of Vermont, Burlington, Vermont, during August 10–16, sponsored jointly by the National Academy of Sciences–National Research Council and the Radiation Research Society in cooperation with the European Committee on Radiobiology. In addition to symposia on "The Role of Oxygen and Peroxides in Radiation Chemistry: Analysis and Correlation of Various Radiobiological Actions on the Same Cell Species (Yeast)", "Free Radicals produced by Irradiation", "Late Effects of Irradiation in Mammals" and "Induced Changes in Deoxyribonucleic Acid and in Chromosome Structure", plenary sessions will be held on the progress and status of radiation research. Further information can be obtained from Dr. Harvey M. Patt, Secretary General, International Congress of Radiation Research, Argonne National Laboratory, Post Office Box 299, Lemont, Illinois.

The Fifteenth International Dairy Congress is being held in London during June 29–July 3, 1959, under the auspices of the International Dairy Federation. In order to assist the authors of contributions in preparing their manuscripts and to ensure a degree of uniformity and high quality among the papers and communications, the Congress authorities have issued a booklet entitled "Instructions to Authors". The booklet is available in three editions—English, French and German—the three official languages of the Congress. It is obtainable from the International Dairy Federation National Committee or the Congress Liaison Officer in each country, or from A. W. Marsden, Organizing Secretary, XV International Dairy Congress, 86 Brook Street, London, W.1. Titles of contributions must reach the organizing secretary not later than June 1, 1958, and the full papers or communications themselves not later than September 1, 1958.

In an article entitled "Machines as Models in Biological Experiments" in *Nature* of April 26, p. 1187, it was implied that "Collected Papers, Vol. 6" of the Laboratory Animals Bureau consisted of a paper by Dr. W. Grey Walter. This is incorrect; the booklet mentioned in the footnote consists of papers and abstracts from a symposium on "Humane Technique in the Laboratory", arranged by the Universities Federation for Animal Welfare, and held in London on May 8, 1957.

MAKERERE COLLEGE

THE School of Agriculture at Makerere College, the University College of East Africa, was opened by the Visitor, H.E. Sir Frederick Crawford, on March 13 in the presence of the Council of the College, its Principal, academic staff, past and present students and many visitors representative of diverse fields of work in East Africa. Prior to the opening, the main entrance of the building was hidden behind a screen of papyrus and local grasses. Sir Frederick, wielding an *omuhoro*, an agricultural implement from south-west Uganda, made for himself a path to gain entry to the School.

The School is placed on a commanding site on the ridge of Makerere Hill and from nearly every room there is an extensive view. The architects were the Kampala firm of Cobb, Powell and Freeman; Mr. Roger Freeman and Mr. R. E. Manwaring having been particularly responsible. They have produced a light, spacious and airy building of graceful proportions and dignified appearance. They have indeed served the College well in making the best use of the £83,000 which was allocated for the building out of a grant of £250,000 given by the East African Governments for the development of the Faculty of Agriculture at Makerere and £30,000 from Colonial Development and Welfare funds.

The building is a two-story one, the general shape of which may be seen from Fig. 1. A central projection to the west houses two lecture theatres, each seating 125. Much thought went into the designing of special seats so that a through-current of air would not be impeded by massive woodwork, an important matter for lectures given at latitude 0° 20′ N. It is hoped that the slatted black-out blinds and doors will make it possible to project films and slides without the audience suffering discomfort.

In the central area there are also a large room for seminars and conferences, a reading room, museum, small service room and cloakrooms. This area can be completely shut off by doors from the other parts of the building so that it is possible to use it for conferences without disturbing the general life of the School. Beyond these doors, on both floors and facing north-east, are private workrooms for the senior members of the Faculty. At present not all these rooms have occupants, but the School has been built to allow for the expansion which should undoubtedly take place over the next ten years.

The north wing houses the Division of Agricultural Chemistry, with a small lecture room which may also be used for examinations and two large teaching laboratories for soil science and pedology and for organic chemistry. Each will hold thirty-two students and each has its own balance room. There are also a number of smaller laboratories for members of staff and research students. This wing has an extensive stores area, which is essential where most

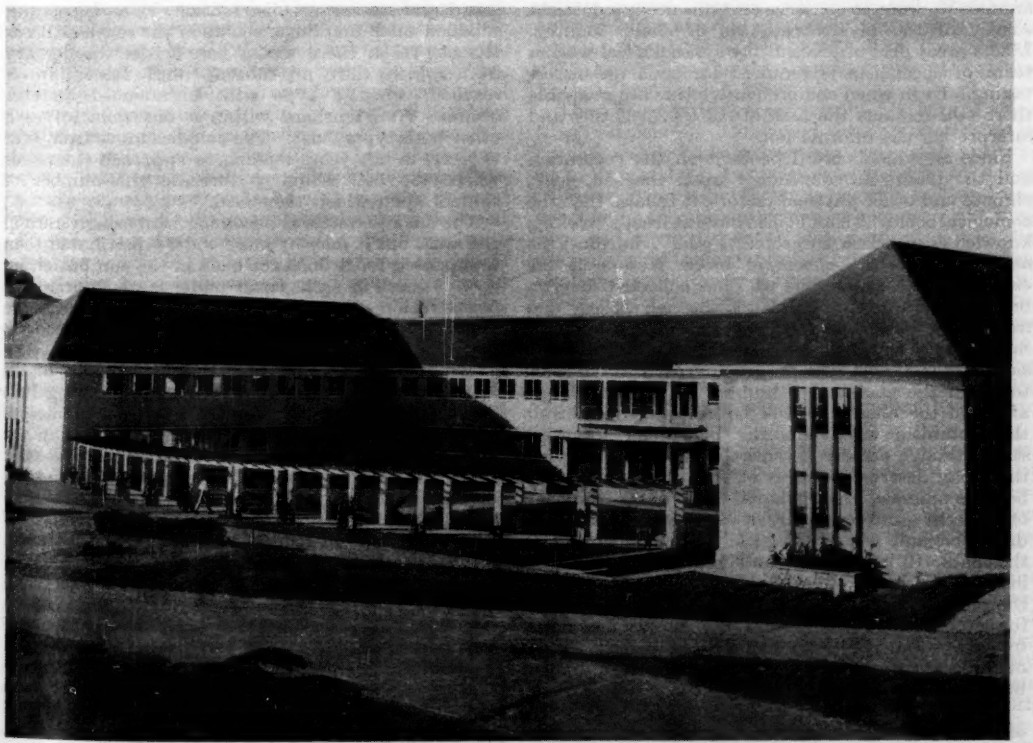

Fig. 1. The School of Agriculture, Makerere College

equipment and supplies have to be imported and large stocks must therefore be carried. A rear access road leads up to the door of this area, and there is an unloading ramp leading into a wide passage-way where goods may be unpacked protected from the weather and predators.

The south wing contains the agricultural botany and agricultural zoology teaching laboratories, and there is a smaller laboratory for teaching animal physiology, one for advanced students and a number of small laboratories for research.

An important adjunct to the central and research building is the University farm, Kabanyolo, 11 miles from Makerere College and close to the Empire Cotton Growing Corporation's main research centre at Namulonge.

We have been fortunate in that we have been able to settle in the new School of Agriculture a few months before the opening of the course for the B.Sc. (Agriculture) degree in special relation with the University of London. As the Faculty develops, we hope that we shall be a centre not only for teaching but also for research, attracting workers from East Africa and beyond. We have undoubtedly been given the physical conditions in which these may proceed.

Margaret A. Keay

CONSERVATION OF NATURE IN SOUTH-EAST ENGLAND

A CONFERENCE on "Conservation of Nature in South-east England", convened by the South-eastern Union of Scientific Societies, was held in the rooms of the Zoological Society of London on April 12, under the chairmanship of the Earl of Cranbrook.

The first paper was on "The Invertebrate Fauna of the Chalk Country and its Conservation". Mr. John Sankey commenced by commenting on the general lack of knowledge of invertebrate ecology, which was surprising when one considers the tremendous amount of collecting which must have been done in the chalk country of south-east England. It is a great pity that collectors have not published more records. He said that before one can speak of the conservation of animals it is necessary to know which animals we want to conserve and this needs a detailed survey of the invertebrate life of chalk country. Like a great deal of present-day synecological work a team of specialists is required for such an undertaking. Even when comprehensive lists are available there still remains the task of sorting, collating and interpreting the information.

Since all animals are dependent on the vegetation and the plants are dependent upon the soil, rock, climate and other physical factors, it follows that the zoological ecologist should also have at least a working knowledge of these subjects. Finally, he must be able to assess the effects of biotic factors in the environment. To anyone who has collected invertebrate animals in our chalklands the rich variety and frequent abundance of many species must be apparent. Such a type of fauna lends itself to fairly effective sampling methods. The proper approach would seem to be in the choice of a number of typical sample areas on the chalk. It will be necessary to consult the botanists when choosing places for intensive study, though one can be entirely dependent on what they may describe as areas of typical chalk country because animals, unlike plants, move about and they often occur quite commonly in places which have been disturbed and which botanically are not typical of the chalk. If, by sampling and listing, we can determine which are the richest and most typical areas of the chalk invertebrate fauna, then we have a basis for conservation of this fauna. Mr. Sankey concluded by saying that it is only through a sound knowledge of the ecology of animals that their conservation can be successfully effected.

Mr. Maxwell Knight spoke upon "The Vertebrates of Frensham Ponds and Romney Marsh". He said he would like to approach the question as if it were the point of view of the animals themselves. If the animals were to be protected, the protection of the environment was necessary. Using the natterjack toad as an example, he said that whereas a few years ago hundreds were present at the large pond at Frensham, to-day, owing to human interference, none existed. Some had become established at the small pond but commercial interference, including boating and fishing, threatened their extinction. The haunt of the natterjack, the reed marshes, had been cleared. The removal of the reeds changed an environment essential for their existence, for the breeding period was a long one, spreading from April to June, so adults, young and tadpoles were together at the same time; at others tadpoles and spawn were together. He next spoke of the sand lizard and its curious distribution. One type, with subdued small markings, occurs in the south as far as Dorset; then there was a belt across the country from which they are absent until Lancashire is reached, when a type with pronounced blotches occurs. At Frensham within a few miles of each other both types exist. The colonies move from year to year, in hot years tending to approach the ponds where the dew helps to increase the number of spiders upon which they feed.

The smooth snake is becoming increasingly rare in the area, but it may be more widely distributed than is supposed for it does not bask in the sun but either goes to earth or seeks cover under large stones. The conservation of an area which would permit the breeding of small rodents upon which it feeds is desirable.

Mr. Maxwell Knight concluded by speaking of the introduction of a few pairs of marsh frog during 1935 into Romney Marsh. It became sufficiently numerous within a few years to have a question asked in the House of Commons regarding its nuisance. Recently there has been a considerable reduction in numbers, possibly due to the fall in the freshwater shrimp population. The question of the desirability of protecting an introduced animal was discussed. The effect of its introduction upon the water population was the disappearance of the common frog and toad, the newt and some of the dragonflies. On the beneficial side it was said that there was an absence of mosquitoes since the introduction of the marsh frog.

Dr. Francis Rose chose as his subject "Possible Nature Reserves in Kent, Sussex and Surrey: a Botanical Ecologist's Viewpoint". He said he wished to deal with his subject under two headings, the plant communities and flora of the Wealden counties; and nature conservation in this region.

The Weald of south-east England, with its partly encircling chalk of the North and South Downs and adjacent coastal areas, is one of the richest parts of Britain both in its range of plant communities and habitats, and the number and variety of plant species. This is due to a number of causes, some very complex; but, to present a simplified picture, we can say that three main features are responsible: (1) The wide range of geological strata outcropping in the region in successive belts, giving rise to a great variety of soil types; (2) the proximity of the region to the Continent of Europe, with the result that, particularly in Kent, many Continental species are represented; (3) the rather humid oceanic climate of the dissected plateau of the Weald, which together with the still more oceanic microclimate of the deep, sheltered valleys has enabled a markedly Atlantic floristic element to extend.

The area has long been affected by the diverse activities of man and this has led, among other things, to the development of such interesting plant associations as heathland, valley bog and chalk grassland. On the other hand, the primeval forest persisted until comparatively recently in the Weald. Now the flora and fauna of this unique region are threatened as never before by the present enormous pressure on all available land for a wide range of purposes. This pressure on land is inevitable, but with careful planning it is possible to set aside small areas of land as nature reserves, to provide both living examples of plant and animal communities and outdoor laboratories for scientific research on these communities. Dr. Rose then spoke of the woodlands of the Weald, saying there are so many types that time would not permit a discussion on them. The Nature Conservancy has already a reserve of coppice-with-standards woodland on the Weald clay, but fine examples of the more natural 'high forest' type, with oak and beech, still exist in West Sussex, and here preservation of a sample is badly needed. On the coastline there are the magnificent shingle beaches of Dungeness, fine estuarine salt marshes, the cliffs and the sand-dunes of Sandwich with their incredibly rich flora. To summarize, very few species have as yet been actually lost as the result of the modern developments and certain rarities have reappeared, but this happy state of affairs is unlikely to last. Properly managed local nature reserves are an urgent need and, if we are to preserve these wonderful communities, the formation of local trusts is essential.

Dr. J. T. Doney, speaking on "Conservation in Hertfordshire", directed attention to the general deterioration of parts of the area, especially of parklands no longer receiving the necessary attention and rapidly becoming derelict sites. Commons still exist and, if negotiations could be successfully carried out, would make good nature reserves. He stressed the need of co-operation with the local and county authorities and said that the detailed county plans broadly met the wishes of his committee. The Hertfordshire County Council needed support on the matter of conservation and the Trust could help with advice upon the preservation of verges which were disappearing, partly as the result of ribbon development. The list of suitable sites for reserves should be carefully reconsidered, ensuring the reservation of places of ecological importance rather than those of pleasant surroundings only. He considered that rather than sites for the preservation of a rare species, those possessing a rich and varied flora and fauna should be recommended.

A symposium on "Naturalists Trust: their Contribution to Nature Conservation" was held during the afternoon.

Mr. Ronald Hickling (Leicestershire) dealt with the structure and nature of a Naturalist Trust. It should be a separate organization with a singleness of purpose. Its purpose was too fundamental for it to be a department of a natural history society, although all naturalists should be brought into the movement of conservation. It was essential that other interests should be represented on a Trust, particularly the Lord Lieutenant of the County and the Planning Officer. The Trust should be a corporate body, registered as a limited company, thus being able to own property and to enter into agreements. With the use of discretion, the cost of the formation of a Trust should be less than £100, and it should be established as a charity working for the benefit of society.

Mr. R. E. Smith (Lincolnshire) spoke next. He emphasized that the increased pace of development gave the opportunity for increased local voluntary action. A Trust should attend not only to safeguarding but also make recommendations of suitable sites for reservation, co-operating with the local planning officers who could designate the areas. It should establish good relations with the Ministry of Agriculture and the Forestry Commission. Where possible, suitable areas should be purchased, otherwise they could be leased by agreement with either private owners or public bodies. Statutory bodies should be influenced to use the powers given to them by the 1949 National Parks Act. Management of a reserve, when funds are available, should be by a paid warden; if this is not possible, voluntary help should be enlisted. The erection of huts for the warden and for use as laboratories is desirable. The Trust should offer assistance in the management of existing Nature Conservancy reserves.

The closing address was given by Dr. Max Walters (Cambridgeshire). He wished the organization to be upon a county basis rather than a city as it tends to be in Cambridge. Publicity was an important part of the work of a Trust, contacts with schools being necessary. He would welcome co-operation with both city and county educational authorities for the distribution of leaflets and the arrangement of evening meetings and excursions for teachers of biology. Talks should be arranged for all local organizations and full use made of the local Press by contributions and letters.

There was a multiplicity of organizations dealing with the problem and a Trust would not only simplify the complexity but would also clarify and co-ordinate the various points of view and aims.

During the discussion following, a landowner, while warmly supporting the movement, spoke of the financial difficulties experienced in the management of his property and welcomed advice upon how help could be given by owners to conservation in such circumstances.

It was announced that arrangements are in hand for the formation of four County Trusts within the south-eastern area: Essex, Kent, Surrey and Sussex. A motion was carried "That an advisory committee be formed to assist and advise those areas which may wish to proceed with the formation of a Naturalists Trust". A committee of five was elected with Mr. Frank Edwards, 53 The Drive, Shoreham-by-Sea, Sussex, as secretary, to whom all communications should be addressed.

F. J. Epps

SCIENCE IN THE TROPICS

UNDER the general title "Science in the Tropics", the annual seminar held at the Institute of Commonwealth Studies recently concluded its fourth year of discussions on the impact of the natural sciences in the tropical countries of the Commonwealth. It was agreed that in some fields of research Britain can contribute much in the way of one-time capital efforts, such as soil and plant-disease surveys and malaria campaigns, but that in the long term, the problem of providing the right incentive to take up scientific studies and to apply them effectively is still largely unsolved. The proportion of 1 : 40 of scientists to technical assistants in one commodity research station was quoted as reflecting the danger of lowering the standard of work that could be done. These stations must of necessity work in isolation from the daily life of the community, although it is the community which must willingly support research and from which the research workers must eventually be provided.

Public relations maintained in a variety of ways, from the inculcation of ideas in early education to frank glamorization and acknowledgment of the work of the scientist, were variously advocated for accelerating the progress of science in tropical countries. The provision of funds for these activities presupposes an awareness by the politician and the administrator of the losses caused by ignorant cultivation, diseases and pests of crops and human beings, and lack of knowledge about their control. The principle of wise investment, either by governments, individuals or co-operatives in scientific research and still more in extension work, involves the denial of present consumption for inassessable future benefits. With alarming increases in population resulting from health campaigns and improved economic systems, many tropical countries will be forced to develop scientific methods capable of producing dramatic increases in food or cash crops. The whole problem of family limitation will have to be faced squarely, especially in India and the Far East.

Scientific studies of diet and nutrition will enable better use to be made of existing crops or to shift the emphasis on to crops of better nutritional value. The education of women in this and other domestic fields was stressed several times during the discussions.

But it was clear that at present the number of research scientists coming forward is hopelessly inadequate to cope with the problems, especially on the continent of Africa, and the only recourse is to invoke massive aid from the older established scientific centres of Europe and America. Such aid is necessarily only forthcoming when the problems have already become sufficiently acute to attract general attention.

Other topics discussed included the important part played by commercial firms in bringing modern applications of science, in the shape of machinery, fertilizers, fungicides and insecticides, to the tropical cultivator. Even in this field the recovery of very large development costs is endangered by commercial competition, and this tends to set back the advance of many scientific applications.

The seminar was under the chairmanship of Dr. W. F. Jepson, of the Imperial College of Science and Technology, London, and the opening speakers were Dr. Herbert Greene, of Rothamsted Experimental Station, on soil studies; Mr. George Ordish, of Imperial Chemical Industries, Ltd., on the economics of tropical research and extension work; Prof. B. S. Platt, of the London School of Hygiene and Tropical Medicine, on nutrition research; Dr. C. G. Johnson, of Rothamsted, on commodity research stations; Mr. V. L. Griffiths, of Oxford, on early education; Prof. G. Macdonald, director of the Ross Institute, on public health; Dr. F. P. Coyne, of Imperial Chemical Industries, Ltd., on the introduction of pesticides into the tropics; and Dr. J. C. F. Hopkins, director of the Commonwealth Mycological Institute, on the impact of plant diseases.

W. F. Jepson

THE NATIONAL RESEARCH DEVELOPMENT CORPORATION

THE report and statement of accounts* of the National Research Development Corporation for the year ended June 30, 1957, covers the eighth year of the Corporation's activities and notes an encouraging rising trend in the royalty income. All sixteen electronic digital computers commissioned by the Corporation are in operation and the Pegasus computer has proved a most successful and popular design. A new project under consideration is concerned with construction of computers several hundred times faster than those at present available. A patent pool has been created for electronic digital computers and, as a member, the Corporation has made all its patents which bear on digital computers available through the medium of the pool licence. Eight scholarships, each for three years, have been made available at the University of Manchester for postgraduate training of computer engineers and programmers, and four annual scholarships at the University of Cambridge for postgraduate students taking the diploma course in numerical analysis and automatic computing.

The Packman potato harvester has been further improved so as to reduce crop damage, and the National Institute of Agricultural Engineering completed development work on its small potato harvester. The design of a complete full-scale prototype regenerative mechanical transmission system is well advanced, and extension to cream of a process developed at the National Institute for Research in Dairying whereby freshly pasteurized milk is treated with ultrasonic waves poured into polyethylene bags and quickly frozen promises to solve the serious problem presented by rapid deterioration of cream in transport and storage. A valuable by-product of the liquid gases plant project has been the development of a stabilized high-speed air bearing.

Development projects noted for the first time in the report include work on the production of aldo-

* National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1956, to 30th June, 1957. Pp. 30. (London: H.M. Stationery Office, 1958.) 2s. net.

sterone by a tissue incubation technique invented at the Middlesex Hospital Medical School; a three-year programme of research and development on the selective removal of gold from cyanide liquors with ion exchange metals; hydrogen–oxygen fuel cells, including the construction of prototypes and the development of high-pressure electrolysers; the development of improved types of exchange membranes and electro-dialysis cells for the purification of salt and brackish liquors and other uses in the chemical, food and antibiotic industries and the treatment of effluents; the development of a groundnut harvester designed by the National Institute of Agricultural Engineering; and the design and construction of a prototype rolling mill to enable thin strip to be rolled in a few passes to thicknesses down to 0·0001 in. Work at the National Institute for Research in Dairying and at the Courtauld Institute of Biochemistry on the structure of mircestrol and at the University of Cambridge on the stability of towed flexible oil barges and methods of preventing their tendency to 'snake' is also being supported.

Of the 631 inventions communicated to the Corporation during the year, 240 were from Government departments and research councils, 100 from universities, 54 from Commonwealth official organizations, 16 from industrial research associations, and 213 from private firms and individuals, of whom 192 were within the United Kingdom and 17 others within the Commonwealth. Of patent rights assigned during the year, 105 were from Government departments and research councils and 26 from universities, while at the end of the year the Corporation held 701 United Kingdom granted patents and 373 patent applications, on which 335 licence agreements were in force, as well as 942 overseas patents and 1,054 patent applications.

THE GRASSLAND RESEARCH INSTITUTE*

THE removal of the Grassland Institute from Drayton to Hurley was completed in September 1955 and the staff has been able to settle down to its programme of research designed to secure a basis for the future progress of pastoral farming in Britain. Research is being carried out by five departments and three units, which together constitute a team working on problems centred on the grass/legume sward involving four main aspects concerned with its development, potential characteristics, level of productivity and its utilization at all times of the year.

The object of the Herbage Agronomy Department is to study ways and means of extending the season during which pasture can be offered to stock. It is also concerned with the influence of management on grass production. Experiments in animal agronomy are concerned with all phases of beef-cattle production from rearing trials to carcass quality studies. Grazing experiments with sheep and pigs and the effect of poultry management on the white clover content of grass/clover swards are also included in the programme. The influence of the botanical composition on soil fertility, the utilization management and the use of nitrogenous fertilizers is being studied by the Ley Agronomy Department. Development of methods for estimating pasture intake by grazing animals, and investigations of the composition of nitrogenous and carbohydrate constituents of herbage plants at different stages of growth are the concern of the Department of Biochemistry and Animal Nutrition. The study of grassland necessitates a sound basic knowledge of the growth and development of different grass species and it is the aim of the Plant Physiology Department to provide this information.

The Unit of Microbiology has so far studied the fungal population of decomposing tissues of ryegrass, but doubtless there will be many other problems that will repay investigation. A station of this kind would not be complete without adequate facilities for statistical consultation and advice, which is provided by the Statistical Unit. Besides its advisory function, the Unit is investigating the particular requirements of experiments carried out at the Station. The Extra-Mural Unit carries out experiments at a considerable number of centres, particularly on the production of winter grass and early bite. The long-term effect of different fertilizer-levels on productivity of leys is being studied.

* Grassland Research Institute. Experiments in Progress No. 9: Annual Report for 1956. Pp. viii+61. (Hurley, near Maidenhead: Grassland Research Institute, 1957.) 5*s*.

LABORATORY ANIMALS

IT is essential that laboratory animals should be bred under stringent conditions, with due regard for their genetic and other characteristics, their freedom from disease and for other factors which may influence the experimental results obtained. The International Committee on Laboratory Animals, founded in December 1956 as an independent body supported by Unesco (*Nature*, **179**, 240; 1957), issues a *Bulletin* on the subject in March and September of each year, the second issue of which (March 1958) has recently been published.

At its meeting last December the Committee recognized the importance of primary type-colonies of breeding stock of known genetic and other controlled characteristics and undertook to help in their selection and establishment. It also recommended the production, translation and distribution of technical manuals on the care of laboratory animals, the preparation and distribution of films and the establishment of a specimen programme of courses for laboratory technicians. It was recommended that scholarships and fellowships should be awarded in the field of animal care, production, genetics, nutrition and disease and the Committee undertook to help both applicants for such awards and those who might make applications.

Surveys have been completed of the production and use of laboratory animals in the Benelux countries, India, Italy, Japan, Scandinavia, Switzerland and the United Kingdom, and a critical analytical

review of the information obtained will be published by Unesco this year. Further surveys are in progress in Australia, France, Turkey and the United States and others are being planned.

Information is being collected about the regulations governing the export, import and international transport of laboratory animals and about humane regulations or recommendations that are in force. The Committee is also organizing an international symposium to be held in October at the Centre de Sélection des Animaux de Laboratoire, Centre National de la Recherche Scientifique, Gif-sur-Yvette, near Paris, which will discuss what provision of laboratory animals is needed, what resources are available to-day, and the work of the International Committee. The proceedings of the symposium will be published.

The *Bulletin* outlines the functions of a national laboratory-animal organization as a recognized centre of information in contact with similar organizations in other countries, the functions of which include keeping a register of important sources of supply of laboratory animals. A list of existing national organizations in the United Kingdom, the United States, Czechoslovakia, France, Holland and Japan, is also given. Similar organizations are being formed in Australia, Belgium, India and Italy. A valuable list of books and other publications on vertebrate and invertebrate laboratory animals of many kinds occupies about seven pages of the *Bulletin*, which also announces the change of title of the United Kingdom Laboratory Animals Bureau to the Laboratory Animals Centre and the removal of this centre on March 31 to its new address at the Medical Research Council Laboratories, Woodmansterne Road, Carshalton, Surrey.

The Collegium Internationale Neuro-Psycho Pharmacologicum is holding its first congress in Rome during September 9–12, and will discuss, among other things, the behaviour of animals in normal conditions and after the administration of psychotropic substances. Further information can be obtained from Dr. C. Radouco-Thomas, 44 Route des Acacias, Geneva, Switzerland. G. Lapage

SURGES IN GLACIERS

By Dr. J. F. NYE

H. H. Wills Physics Laboratory, University of Bristol

Attention has been directed by Lighthill and Whitham[1,2] to a class of wave motions which are physically quite distinct from the classical wave motions in dynamical systems. They show that these so-called kinematic waves exist in a one-dimensional flow system if there is an approximate functional relation, at each point x, between the flow q (quantity passing a given point in unit time, for example, number of vehicles on a road), and the concentration k (quantity per unit distance). The wave property follows directly from the equation of continuity satisfied by q and k, namely:

$$\frac{\partial k}{\partial t} + \frac{\partial q}{\partial x} = 0 \qquad (1)$$

They show that there are waves of constant q which travel with a velocity:

$$c = \left(\frac{\partial q}{\partial k}\right)_x$$

In general, c is different from the velocity v of the medium itself, which is given by q/k. They applied the analysis to flood movements on long rivers[1] (of which some independent treatments had already been given), to the group velocity phenomenon[1], and to traffic flow on long, crowded roads[2]. Frank has used a similar method to analyse the movement of small steps over a crystal face during crystal growth and evaporation (private communication). Now it appears that the same analysis may be used to explain the passage of surges through glaciers.

The movement of bulges of increased thickness down a glacier faster than its normal flow has been postulated, because increased accumulation by snowfall in the upper part of a glacier makes itself felt at the lower end long before any of the new material can have been carried that far. As remarked by Sharp[3], this was spectacularly demonstrated by the sudden advance of several glaciers in the Yakutat Bay region, Alaska, a few years after the severe earthquake of 1899, which shook down much ice and snow on to the heads of these ice streams. A bulge of increased thickness is reported to travel with a velocity of 3–4 times that of the glacier[3].

To apply Lighthill and Whitham's analysis we identify q with the discharge (volume of ice passing a given cross-section per unit time) and k with the thickness of the ice. Then to work out c we need to know the dependence of q on k. The simplest case is a very wide glacier of rectangular cross-section. A theoretical treatment[4] gives q as the sum of two terms, one due to plastic deformation in the bulk of the ice, and the other due to sliding of the ice over its bed; for unit width,

$$q = ak^{n+2} + v_b k \qquad (2)$$

In this equation, a is a constant for given x, determined by the flow properties of ice, its density, and the slope of the channel. n is the power in the quasi-viscous creep law of ice,

$$\text{rate of shear-strain} \propto (\text{shear stress})^n$$

and is found experimentally[5] to be about 3 or 4. v_b is the velocity of sliding on the bed, and it will depend on k in a way that is not easy to estimate. On Weertman's theory[6], in a glacier the bottom surface of which is at the pressure melting point, v_b at any point is proportional to the $(n + 1)/2$ power of the shear stress in the bottom layer of the ice. This shear stress is directly proportional to k (ref. 4). Hence we may write, tentatively,

$$v_b = bk^{(n+1)/2}$$

where b is a constant for a given x.

We therefore have, at a given x,

$$q = ak^{n+2} + bk^{(n+3)/2}$$

Thus, $c = \mathrm{d}q/\mathrm{d}k = (n + 2)ak^{n+1} + \frac{1}{2}(n + 3)bk^{(n+1)/2}$. But v, the mean velocity of the ice over the section, is given by:

$$v = q/k = ak^{n+1} + bk^{(n+1)/2}$$

and hence,

$$c = (n + 2)v - \tfrac{1}{2}(n + 1)v_b \qquad (3)$$

For $n = 3$, $c = 5v - 2v_b$, and for $n = 4$, $c = 6v - 2{\cdot}5v_b$.

Little precise knowledge exists of velocities of sliding in glaciers, but necessarily $0 \leqslant v_b < v$. It follows that $3v < c \leqslant 6v$, which is in agreement with the reported range of values for c noted above.

This simple theory is of course only a first approximation, for the q—k relation (2) is only approximate, even for a rectangular cross-section (it breaks down, for example, when longitudinal strains occur in a glacier[7]). Moreover, q in a glacier will not be determined entirely by k, but also to some extent by $(\partial k/\partial x)$ and higher derivatives, and this would have to be taken into account in the next approximation. There is also the effect of accumulation and ablation —that is, the annual gain of ice by the glacier by snowfall and avalanching in its upper parts, and the annual loss of ice by melting and evaporation in the lower parts. To include these effects a source term $\mu(x,t)$ must be added on the right-hand side of the continuity equation (1). Lighthill and Whitham treat this development in their discussion of the effect on a river of tributaries and run-off. It follows from their analysis that, if μ is a function of x alone, a wave will still pass down the glacier at the speed calculated above, but it will be a wave not of constant q but of constant $(q - \int \mu dx)$. In other words, the accumulation or ablation will be simply superposed on the wave motion.

Since the velocity c depends on the flow q carried by the wave, kinematic waves suffer change of form exactly as do travelling sound waves of finite amplitude. There is thus the possibility of faster waves overtaking the slower ones and their coalescence to form (in the ideal case) discontinuities. Lighthill and Whitham call the discontinuities shock waves, by analogy with the shock waves in a gas, and they calculate their properties in some detail. One would expect such kinematic shock waves in a glacier, since c increases with q. A comparatively gradual increase of the flow q at the head of a glacier would be converted by shock-wave formation into a rapid increase at the lower end, and would cause a rapid advance of the glacier in its valley. On the other hand, a decrease in q at the head would not lead to a shock wave. We should therefore expect glacier snouts to show sudden advances but slower retreats. The advance and retreat of glacier snouts is notoriously erratic. Perhaps some of the erratic movements can be correlated with the arrival of shock waves. If so, an analysis of shock-wave propagation might well help to solve the difficult problem of linking the advance and retreat of glacier snouts with climatic changes, and especially with changes in snow precipitation. It appears that the greater part of Lighthill and Whitham's general analysis will apply to glaciers without substantial change: in particular, their discussion of the path of a shock wave in the (x,t)-plane, the growth and decay of the wave, and its modification by diffusive effects (which determine the thickness of the wave).

There seems to be a wide field here both for theory and for measurement. A good preliminary experiment might be to measure (dv/dk) at a fixed point as a surge passes. Then the velocity of the surge, which would also be measured, should be given by:

$$c = \frac{d}{dk}(vk) = v + k\left(\frac{dv}{dk}\right)$$

I should like to acknowledge with thanks that Prof. F. C. Frank first suggested to me the possible relevance to glaciers of the work of Lighthill and Whitham.

Note added in proof. Since submitting this article, there has come to my notice a paper written in 1907 by S. Finsterwalder[8] in which equation (1), including an ablation term, is applied to a glacier. Finsterwalder uses a power law relation $v = ak^m$ and deduces waves. For numerical calculations he gives m the value 0·5. This value now seems much too small; the equation of the present analysis (with $n = 4$), corresponding to Finsterwalder's $v = ak^{0{\cdot}5}$, is $v = ak^5 + bk^{2{\cdot}5}$. Finsterwalder studied the effect of a very sudden increase or decrease in the rate of feed of the glacier, but he did not envisage the formation of shock waves from comparatively gradual increases in feed. I hope this article may help to renew interest in the work which Finsterwalder began.

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[4] Nye, J. F., *J. Glaciol.*, **2**, 82 (1952).
[5] Glen, J. W., *Proc. Roy. Soc.*, A, **228**, 519 (1955).
[6] Weertman, J., *J. Glaciol.*, **3**, 33 (1957).
[7] Nye, J. F., *Proc. Roy. Soc.*, A, **239**, 113 (1957).
[8] Finsterwalder, S., *Z. Gletscherkunde*, **2**, 81 (1907).

IONIC BOMBARDMENT CLEANING OF GLASS

By L. HOLLAND

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EXPERIMENTS are being made in this Laboratory to find the process by which glass surfaces are cleaned in a glow discharge in the 1–5-kV. range. The cleanliness of the treated surfaces are determined by measuring their coefficients of friction and wetting characteristics. Metal systems fitted with oil-diffusion pumps and rubber seals are used. It has been found repeatedly that a glass surface facing a pure aluminium cathode gradually develops a hard and optically absorbing deposit on its exposed surface as the bombardment progresses. The rate of formation of the discoloured layer is greatest when the glass is within the cathode dark space. Glasses immersed in a glow discharge with the cathode electrode shielded from the glass surface may be cleaned without developing a light-absorbing coating.

Numerous sources of surface contamination arising from exposure to the cathode were considered, including sputtering of a partially reduced aluminium oxide film, reduction of the oxides in the glass under bombardment of high-velocity electrons, and decomposition of hydrocarbon molecules temporarily con-

densed on the surface exposed to bombardment as found by Ennos[1] in high vacuum.

The absorbing layer did not become metallic when the residual gas was changed from air to argon as would a sputtered deposit. Also, electron irradiation at voltages higher than those used would normally be necessary to induce optical absorption in glasses. It is known that hydrocarbon vapours introduced into a glow discharge may be decomposed into less-volatile components, and it is assumed that organic vapours emitted from the components in the vacuum system are similarly decomposed. It was established that surface films formed in the presence of silicone vapour could be wetted and possessed a high coefficient of friction, whereas those formed in hydrocarbon vapour could not be wetted and had a low coefficient of friction.

In order to study separately the effects of positive ion and electron bombardment on glass surfaces, an apparatus was built in which the anode and cathode electrodes were made from two aluminium grids behind which test glasses could be placed. When operated at 3 kV. and 0·2 m.amp./cm.^{2} in air, a yellow light was emitted by the glass bombarded by ions due to the ionization of the sodium component. The yellow glow also appeared on the cathode electrode as the sodium or its compounds vaporized from the glass. After treatment, the electron-bombarded plate had an optically absorbing layer on its surface forming an image of the anode grid. The glass bombarded by positive ions was free from absorption, and had a higher transmission in the bombarded regions, which showed a low reflectance interference colour attributed to the formation of a porous silica surface. Optical examination showed that the bombarded zones were pits in the surface. A whitish deposit appeared in the unbombarded zones, as the sodium which had recondensed on the glass became converted to the hydroxide. A glass plate treated as above was washed in water to remove the loose hydroxide. The bombarded surface was then coated with evaporated aluminium without further treatment. After metallizing, minute gas bubbles appeared under the aluminium, forming a pattern of the unbombarded zones (Fig. 1).

A glass plate, placed behind the anode grid for one hour to produce an absorbing layer on its surface, was cleaned by the ion bombardment when transferred to the cathode grid for the same period. This effect occurred in both air and argon. A deposit was not formed when the electrodes were operated from an a.c. source, presumably because the ion bombardment removed the deposit produced by the electrons on each cycle.

Fig. 1

In order to determine whether the discoloured deposit arose from sputtering or electron bombardment, an apparatus was used in which the electron beam from a hollow cathode was bent by a magnetic field and made to strike a test glass shielded from possible cathode sputtering. However, a discoloured deposit still appeared on the electron-bombarded glass and its rate of formation could be increased by bringing a source of hydrocarbons (for example, a rubber gasket) near to the surface. It follows that cathode-sputtered films deposited in kinetic systems must contain decomposed hydrocarbons.

Further experiments have established that clean glass surfaces may be produced if the electrons leaving the cathode are made to travel in directions which avoid collision with the work surface while the positive ions are scattered by gas molecules and strike the work. Using this system clean glass surfaces have been produced in both argon and air, suggesting that a mechanical rather than a chemical process is responsible for cleaning.

Thus, Hiesinger[2] has described a 'V' cathode electrode for use in a vacuum evaporation plant, but this arrangement produces contaminating deposits if operated for sufficient time, because the work is exposed to electron bombardment. A 'V' cathode operated with a 16 in. diameter holder produced a film with an optical absorption of 1·5 per cent on a glass bombarded for 10 min. at 2 kV., 400 m.amp. in air at 10^{-2} mm. mercury, although an ultimate pressure better than 10^{-5} mm. mercury could be obtained in the chamber. Fig. 2 shows an electrode system which produces clean glass surfaces free from optical absorption when operated at 3 kV. and 400 m.amp. even in the presence of volatile oils. It consists of two electrode rods arranged radially under the work holder. Each of the rods is covered with a shield so that the electrons are accelerated sideways to the glass[3].

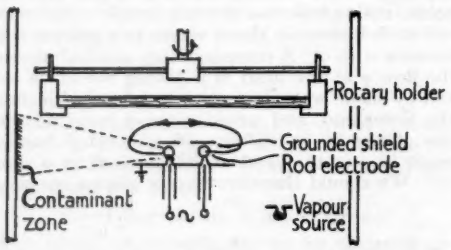

Fig. 2

It is concluded that electrons formed in a glow discharge decompose hydrocarbon molecules absorbed on surfaces which they strike, whereas positive-ion bombardment removes surface contaminants from glass and at high current-densities may remove components from the glass. Furthermore, clean surfaces may be prepared in the presence of hydrocarbons providing the electron bombardment is reduced in preference to ion bombardment.

Acknowledgments are made to Mr. T. Putner and Mr. L. Elsworth for the valuable help they have given during this work and to Mr. A. S. D. Barrett, technical director of Edwards High Vacuum, Ltd., for permission to publish this communication.

[1] Ennos, A. E., *Brit. J. Appl. Phys.*, **4**, 101 (1953).
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LIGHT AND SEXUAL MATURITY IN THE DOMESTIC FOWL

By T. R. MORRIS and S. FOX
Lane End Farm, University of Reading

IT is well established that artificial light improves winter egg production in the fowl[1]; but the effects of light on the development of sexually immature pullets have received less attention. It has been pointed out that pullets hatched late in the spring take longer to mature than pullets hatched in the winter and early spring, and this effect has been attributed to the shorter days which late-hatched birds encounter as they approach maturity[2]. Some experimental evidence indicates that sexual maturity can be advanced by artificial light[3], and other workers have shown that additional light applied during the rearing stage delays maturity[4].

The object of this article is to report some preliminary conclusions drawn from an experiment initiated in 1954 and now in process of analysis. Rhode Island Red × Light Sussex pullets were hatched at weekly intervals throughout the period June 2, 1954–February 8, 1956. 64 pullets from each hatch were reared in natural daylight to 16 weeks of age when the survivors were divided at random into two groups and transferred to individual cages in a battery house. One group received daylight only, while the other had supplementary light during September–April to maintain a 14-hr. day. 89 weekly hatches, involving 5,188 pullets, were housed, and 93 per cent of these birds came into lay by the time they were 30 weeks old, when 3 hatches out of 4 were discarded. Every fourth hatch was transferred at 30 weeks to another battery where both groups were provided with supplementary lighting throughout the winter (14-hr. day) and where recording was continued to 500 days of age.

Fig. 1 shows the average age at first egg for each hatch reared, with and without artificial light. There is a clear seasonal pattern with a 12-months periodicity, the earliest maturing pullets being those hatched in December and the latest those hatched in June. Sexual maturity was advanced by the application of light from 16 weeks onwards; but this treatment did not eliminate all seasonal variation in maturity. This implies either that seasonal factors other than light influenced rate of maturity or that the light pattern experienced by the bird before 16 weeks of age had an important effect on age at first egg.

An analysis of our results and of other published evidence has led us to the belief that the rate at which a pullet approaches sexual maturity is increased by increasing lengths of day and decreased by decreasing lengths of day. The important factor is not the length of day but the rate at which day-length is changing.

The summation of all changes in day-length occurring during the growing period is measured by the net increase between hatch and maturity and this shows a high correlation with age at sexual maturity ($r = -0{\cdot}9115^{***}$). Evidence is not yet available to show how the pullet's response to unit change in day-length varies with age or how birds respond when subjected to sudden artificial changes in day-length.

The regression of age at maturity on day-length change for our flock is given by:

$$y = 166 - 1{\cdot}64\ (d_M - d_H)$$

where y is age at sexual maturity (days), d_M is day-length at maturity (hr.), d_H is day-length at hatching (hr.).

This formula predicts that (at 51° N.) birds hatched in late April and reared under constant day-length will mature about 6 days earlier than natural-daylight controls whereas November hatches reared with constant day-length will mature some 8 days later than controls receiving only natural daylight. This explains why some workers have found that lights advance maturity and others that lights delay it.

This experiment also throws some light on the much-debated question of whether early sexual maturity in the fowl is commercially desirable. Each of the 44 groups of birds which was recorded to 500 days of age was notionally divided into five equal parts on the basis of the birds' ages at sexual maturity. The information from corresponding quintiles in all groups was then amalgamated to show the average effects of early sexual maturity 'within a hatch' for birds hatched at all seasons of the year.

This evidence, which is presented in Table 1, shows that early sexual maturity 'within a hatch' was an advantage whether lights were applied early or late.

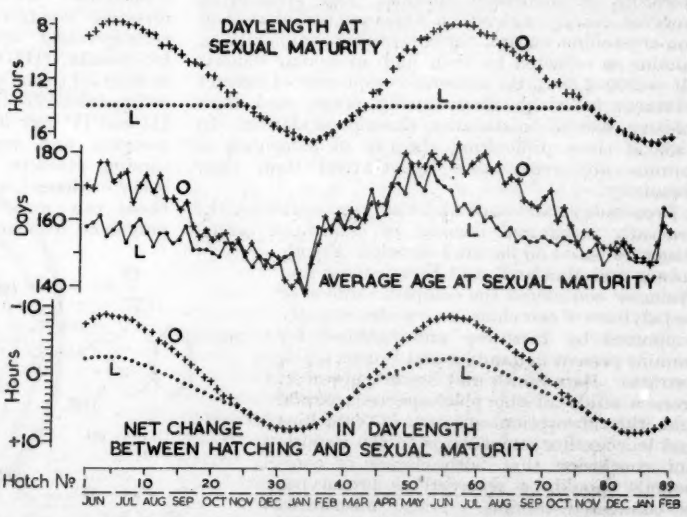

Fig. 1. Average age at first egg (centre figure) for groups of pullets hatched at weekly intervals throughout 21 months and reared with natural daylight only (*O*) or with supplementary artificial light from the age of 16 weeks onwards (*L*). The upper figure shows the day-length at the time of average first egg for each group and the lower figure shows the change in day-length (day-length at maturity minus day-length at hatching) experienced by each group

Table 1. The Effects of Early Sexual Maturity on Subsequent Egg Production
(Data for 2 × 22 groups hatched over a period of 84 weeks)

Time of sexual maturity relative to the hatch median	No. of pullets		Average age at sexual maturity (days)		Average egg production per pullet housed (to 500 days)		Egg production as a percentage of opportunity days†	
	Lights applied at:							
	16 wk.	30 wk.	16 wk.	30 wk.	16 wk.	30 wk.	16 wk.	30 wk.
Very early	127	125	143	148	217	231	61	66
Early	117	114	150	156	205	223	59	65
Medium	113	119	155	162	207	202	60	60
Late	117	114	161	169	193	204	57	62
Very late	127	125	174	185	180	176	55	56
Totals:	601	597	Means:		200	207*		

*Difference: 7 eggs ($P < 0.05$)
† (Average eggs per bird to 500 days) × 100 / 500—Average age at sexual maturity (days)

The last two columns of Table 1 show that this advantage is partly attributable to a higher rate of lay and is not merely the result of allowing the early starters a greater opportunity to lay by arbitrarily terminating the experiment at a fixed age. The pullets which were first lit at 30 weeks of age laid an average of 7 eggs per bird more than those lit at 16 weeks, indicating that forcing the birds into lay with lights eventually resulted in a decrease rather than an increase in annual yields.

Since the differences between early maturing and late maturing birds 'within a hatch' are largely genetic in origin it is suggested that the key to the controversy about the merits of early sexual maturity in the fowl is a paradox: breeding for early sexual maturity leads to increased yields whereas light patterns, and perhaps management practices in general, which advance maturity lead to a reduction in yield.

There is some evidence that pullets hatched early in winter tend to lay small eggs for a prolonged period and perhaps have lowered annual egg yields. These are presumably consequences of precocity resulting from exposure to increasing spring day-lengths during the growing period. A practical remedy may be to apply additional light in the growing stages in such a way as to eliminate the natural daylight pattern. This possibility is being investigated.

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BIOGENESIS OF CONDENSED TANNINS FROM LEUCOANTHOCYANINS

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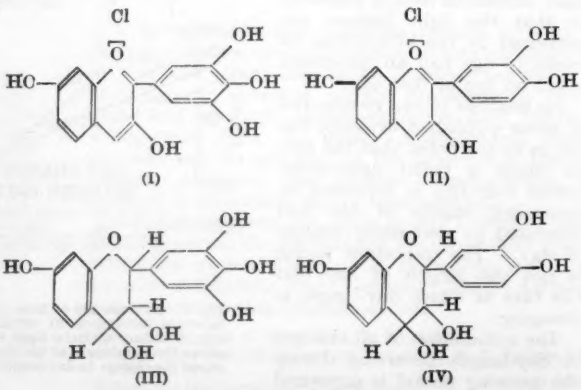
In the field of chemical research on the commonly occurring natural products of vegetable origin, there are few instances where so little fact has given rise to so much speculative theory as is found in the literature on condensed tannins. This position is, however, readily understood when one considers their non-crystalline nature, the structural complexity of tannins as reflected by their high molecular weights (M = 600–2,500), the extreme complexity of extract mixtures in which they usually occur, and their relative ease of denaturation through oxidation. In view of these difficulties, theories of biogenesis of tannins are even more hypothetical than their chemistry.

Freudenberg and co-workers are responsible for the generally recognized concept of condensed tannin structure based on flavan-3-ol units. Freudenberg and Maitland[1] and Freudenberg and Weinges[2] considered the complex tannins to be polymers of catechins, a view also recently supported by Hathway and Seakins[3] for tannins present in gambier and Burma cutch extracts. Bate-Smith and Swain[4], however, from a study of the phlobaphene reaction and the absorption spectra of catechins and leucoanthocyanins came to the important conclusion that both classes of compounds should be regarded as prototypes of condensed tannins. Hillis[5] afterwards expressed the view "that the leucoanthocyanins in the xylem originate from the leaves of plants and that they are the immediate precursors of bark and heartwood extractives (tannins)".

Recently, following a study of synthetic and naturally occurring anthocyanidins[6], I have shown that both high- and low-molecular fractions of wattle and quebracho extracts may be converted into robinetinidin (I) and fisetinidin (II)[7] under specific conditions[8]. As this conversion is also given under identical conditions but in higher yield by the corresponding synthetic flavan-3.4-diols, leucorobinetinidin (III)[9] and leucofisetinidin (IV)[7], this finding led to the surmise that polyleucorobinetinidins and polyleucofisetinidins based on structural formulæ III and IV may in part, if not mainly, constitute the complex and true tannins of these commercial tanning extracts. This view was also supported by other evidence[7], and is now confirmed by a study of those raw materials from which monomeric and polymeric leucoanthocyanins originate.



Quebracho extract, for example, is obtained from the commercial exploitation of only two species of the genus *Schinopsis* (fam. Anacardiaceae), both indigenous to the Argentine and Paraguay: (*a*) *Schinopsis balansae* Engl. ('Chaqueno') and (*b*) *Schinopsis quebracho-colorado* (Schlechter) Bark et Meyer ('Santiagueno') (syn. *S. lorentzii* Engl.). The heartwood of *Schinopsis balansae* is richer in tannin, containing on an average some 20–25 per cent tannins as against 16–17 per cent for *S. quebracho-colorado*[10]. The latter tree, *S. quebracho-colorado*, contains sapwood which is usually hewn off prior to transport for eventual manufacture of extract, in order to reduce the weight of the logs, and to prevent insect attack[10]. Chromatographic comparison of the heartwood extractives of these trees shows similarity in the general composition of the polyphenolic tannins present. They both contain a mixture of complex leucofisetinidins, of which the monomeric form IV was found absent in the commercial extract[7].

Examination of the sapwood of *S. quebracho-colorado* by paper chromatography revealed the presence of a monomeric leucofisetinidin (7.3′.4′-trihydroxyflavan-3.4-diol) in exceedingly high concentration. Thus from 200 gm. of the cross-section of a sapling of this tree (7–8 cm. diameter) containing only a trace of black heartwood (about 1 cm. diameter), 3·4 gm. of leucofisetinidin could be isolated, forming about 10 per cent of the total phenolic extractives ('tannins') present in the sapwood. The *l*-leucofisetinidin thus obtained is similar but not identical with the *dl*-7.3′.4′-trihydroxyflavan-3.4-diol obtained from the hydrogenation of 2.3-dihydrofisetin (fustin)[6]. The extractives from various regions of the sapwood of this specimen were afterwards examined by means of radial sampling of the cross-section, from the outer sapwood to the heartwood (Fig. 1). The acetone–water extracts of the drillings, were examined by paper chromatography (Fig. 2, *A*–*E*). The chromatograms show that the monomeric leucofisetinidin (*LF*) gradually disappears, from the outer sapwood where it is present in highest concentration, towards the central pith. Compounds of intermediate mobility in direction 2 gradually increase over samples *A* and *B* to reach a maximum in *C*, and then decline somewhat in concentration towards the heartwood. The immobile tannins in direction 2 gradually build up in concentration over samples *C* and *D* to reach a maximum in the heartwood sample *E*. Recent work at this Institute[11] has shown that quebracho tannins increase stepwise in complexity from a molecular weight of 700, for the most mobile polyphenols in direction 2, to the completely immobile polyphenols of molecular weight 2,500 (immobile in direction 2). I have also shown that each of these fractions gives fisetinidin in about 5 per cent yield on treatment with hydrochloric acid under the optimum conditions.

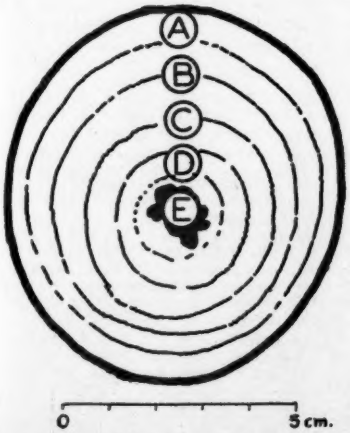


Fig. 1. Cross-section with sampling positions of a sapling of *Schinopsis quebracho-colorado*. Samples obtained by drilling. The small 'heartwood' is shaded black, the remainder being sapwood

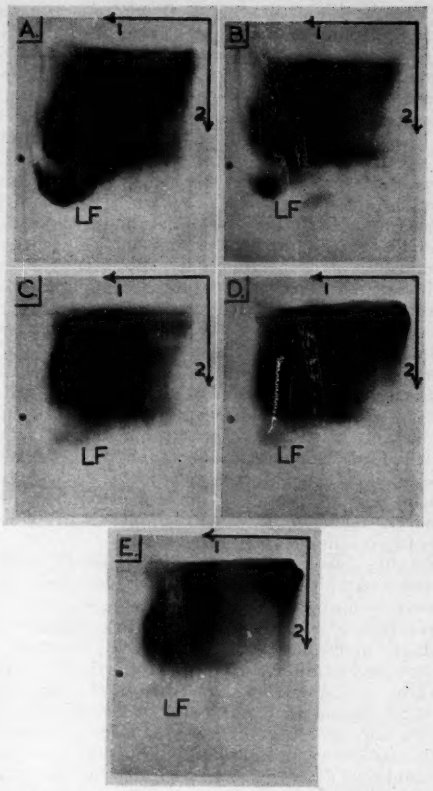


Fig. 2. Paper chromatograms of the extractives of the sapwood of *Schinopsis quebracho-colorado* obtained by radial sampling (see Fig. 1). The most mobile constituent in direction 2 (*LF*) is leucofisetinidin, while the least mobile constituents on the starting-line in the same direction are the most highly condensed tannins (polyleucofisetinidins). Chromatograms run in water-saturated *sec.*-butanol (direction 1) and 2 per cent acetic acid (direction 2), and sprayed with ammoniacal silver nitrate

Apart from the isolation and presence of the monomeric leucofisetinidin in high concentration in association with quebracho heartwood tannins, the above work provides presumptive evidence of its transformation in the sapwood, to the various polymeric forms present in the heartwood. Evidence of apparent secondary condensation of polymers of intermediate dimension to those more highly condensed forms, which constitute a relatively high percentage of quebracho extract, is also provided. The leucofisetinidin, 7.3′.4′-trihydroxyflavan-3.4-diol, may therefore be regarded as the possible 'precursor' of quebracho extract.

Confirmation of this concept was obtained by examining the sap- and heart-woods of the Australian blackwood tree, *Acacia melanoxylon* R. Br., by a similar radial sampling technique. King and Bottom-

ley[12] found that its heartwood contains the monomeric leucoanthocyanin, melacacidin, and I have shown[7], with the aid of the diagnostic toluene-*p*-sulphonic acid spray reagent, that two such leucoanthocyanins, probably geometrical isomers, are present. In the narrow sapwood of *Acacia melanoxylon* the melacacidins form the major constituents. In the 'heartwood' zone, however, tannins of low R_F are also present, which increase in concentration from the outer heartwood towards the central pith. These tannins of low R_F yield the same anthocyanidin, 3.7.8.3′4′-pentahydroxyflavylium chloride, as do the monomeric melacacidins. The monomeric leucoanthocyanins which predominate in the sapwood may therefore also be regarded as probable 'precursors' of the condensed heartwood tannins.

Similarly for black wattle wood (*Acacia mollissima*), complex tannins of low R_F are associated with the monomeric leucoanthocyanin, mollisacacidin[13], in the heartwood. Both yield the anthocyanidin fisetinidin on treatment with hydrochloric acid and may be regarded as leucofisetinidins. The closely related species *A. decurrens* (green wattle), *A. dealbata* (silver wattle) and *A. pycnantha* (golden wattle) show the same association between simple and complex leucofisetinidins in their heartwoods.

Finally, black wattle tannins derived from the extractives of the bark of *Acacia mollissima* Willd. (known commercially as 'mimosa' extract) were shown by me[7] to contain complex leucorobinetinidins of high molecular weight (major proportion) and also leucofisetinidins (minor proportion). Careful scrutiny of the extract derived from absolutely fresh bark, extracted with methanol in the cold, has now shown the presence, in very low concentration, of both monomeric leucorobinetinidin (III) and leucofisetinidin (IV), which are regarded as the possible precursors of some of the tannins present in the extract[7]. This is the first occasion on which the leucorobinetinidin, 7.3′.4′.5′-tetrahydroxyflavan-3.4-diol[8], has been identified from natural sources.

The apparent transformation of monomeric ('non-tannin') leucoanthocyanins into polymeric leucoanthocyanins (or 'tannins') in the case of *Schinopsis quebracho-colorado* and *Acacia melanoxylon*, and also the co-existence of leucoanthocyanins of varying complexity but of similar basic structural pattern in the above and other species examined, is regarded as highly significant. Although both simple and complex leucoanthocyanins could originate from common precursors, the evidence points to the formation of polymeric leucorobinetinidins and leucofisetinidins, representing some of the true tannins of wattle and quebracho extracts, from the corresponding monomeric flavan-3.4-diols by enzymic condensation *in vivo*. Their mode of condensation is such that the flavan-3.4-diol structure remains either intact or potentially available, to yield the corresponding anthocyanidins under appropriate conditions of treatment. Furthermore, the mode of linkage between the C_6–C_8–C_6 units in the tannins is such that it is labile at 100° C. and 2–3 atm. pressure in the presence of 0·6 *N* hydrochloric acid. The presence of other links is suspected[7]. In the woody tissues of trees, the differentiation between heartwood and sapwood is based on the presence of relatively high proportions of highly condensed tannins in the former which are either absent, or present in lower concentration, or in special cells, for example, medullary rays[14], in the latter. Such highly condensed tannins undergo oxidative browning more readily than the monomeric forms, and are thus responsible for the dark coloration developed by heartwoods.

The biochemical condensation of monomeric leucoanthocyanins discussed above cannot be regarded as the only method through which tannin formation occurs in Nature, nor can the mode of condensation be necessarily completely regular. Complex leucoanthocyanins are, however, exceptionally widely distributed[14,16] and have been found present in 33 per cent of 144 heartwood samples examined in these laboratories. Also it is clear from the above work that little parallel exists between the oxidative conversions or condensations induced by hydrochloric acid of 'flavonoid' or 2-phenylbenzopyran structures, and the biogenesis of naturally occurring tannins, which are likely to result from enzymic action only.

The radial increase in complexity of tannins from sapwood to heartwood, and the wide differences between tannin mixtures present in the heartwood and bark of certain trees, for example, *Acacia mollissima* Willd. (black wattle), *A. decurrens* Willd. (green wattle), and *A. dealbata* Link. (silver wattle), suggest that two different enzymic systems operate for bark and heartwood tannins. The above evidence of the biogenesis of tannins in the barks and woods by the apparent conversion of monomeric leucoanthocyanins (molecular weight about 300), which are incapable of tannage[17], into polyleucoanthocyanins (molecular weight greater than 700–1,000), capable of tannage, together with similar evidence previously obtained from the depolymerization of tannins[7] places the chemistry of condensed tannins of this class on a more satisfactory basis.

Thanks are due to Prof. Enrique C. Clos, Division de Exploraciones e Introduction de Plantas, Ministerio de Agricultura y Ganaderia, Buenos Aires, for samples of quebracho woods; and to Dr. Humberto Giovambattista, L.E.M.I.T., La Plata, for assistance; to Dr. S. P. Sherry, Wattle Research Institute, Pietermaritzburg, for samples of the mature woods of black, green and silver wattles; and to Miss G. V. Britten, of the Botanical Survey, Union Department of Agriculture, Albany Museum, Grahamstown, for the identification of *Acacia melanoxylon*.

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Note added in proof. This article was submitted to *Nature* on August 8, 1957; related work has been discussed in 'letters' in recent issues of *Chemistry and Industry*.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Origin of Tektites

THE Moon as a source of tektites is accepted by Varsavsky[1] on the basis of calculations which indicated to him the probability that ejecta from meteorite impacts on the Moon could reach the Earth. All other evidence to the contrary was either ignored or misinterpreted. In *Nature* recently, O'Keefe[2] and Gold joined Varsavsky in support of such an origin.

As pointed out by Urey, in a following communication, and by me[3], it is improbable that the Moon could furnish material having the composition of tektites. The distribution of tektites on Earth furnishes other objections to such an origin.

If tektites are ejecta from meteorite impacts on the Moon, then the slow spiralling of this lunar material to Earth, as suggested by O'Keefe, should result in a fairly uniform distribution of tektites in a broad zone about the Earth, as well as a fairly uniform distribution in geological strata from the time of the arrival of the first tektite on Earth. This is not the case. Tektites came to rest in groups, not as individuals arriving randomly as happened with ordinary meteorites. Various groups are widely separated in time with no individuals as yet found to have arrived in between such times.

Other tektite groups will undoubtedly be found, and the margins of known tektite-strewn fields will be widened as search continues; however, it seems very unlikely that a world-wide distribution of tektites, such as must be postulated for slow inward spiralling of lunar material, will be found. Many of the Australian finds are in unpopulated areas where people seldom go, yet in most populated areas of the world no tektites have been found. After my article[4] appeared in a service publication which reaches most geologists and geophysicists in the United States, many glass objects were received by me for identification, but none was of tektite origin. The chance therefore of finding tektites elsewhere in the United States would seem to be limited.

Every instant of geological time since the first tektite came to rest is preserved in the stratigraphic succession in many places throughout the world, and in places the thickness of rock accumulated during this time amounts to miles. If tektites arrived continuously, then tektites should be found throughout this succession instead of at fewer than a dozen levels, each limited to a very small part of the Earth. In Texas, for example, the rock succession during this interval is fairly complete yet tektites have been found only on rocks of Jackson age or in alluvium derived therefrom. I have mapped in detail several thousand square miles in Texas and visited virtually every part of the State without finding a single tektite specimen except in seven counties for a distance of 120 miles along the Jackson belt of outcrop. If tektites are uniformly distributed, it seems unlikely that they would have been missed in all these other localities.

A few tektite groups have characteristics distinguishing them from all other tektite groups. Libyan Desert glass, for example, is nearly pure silica of a transparent, straw-yellow colour; moldavites are a transparent, clear green; and australites include button forms. Each of these characteristics is peculiar to the group concerned and is found in no other group. Such a segregation of tektites displaying distinctive characteristics should be sufficient in itself to discredit the theory of the slow spiralling of lunar material to Earth.

Varsavsky's origin is different from that of O'Keefe. Varsavsky suggests that ejecta from meteorite impacts on the Moon would come directly to Earth. Each tektite group, then, would represent a separate ejection, and the nearly pure silica glass of the Libyan Desert would be just one of the ejections. It seems preposterous in the light of geological knowledge to assume that nearly pure silica could have segregated on the surface of the waterless, airless Moon.

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RECENT communications in *Nature*[1], defending the lunar origin of the tektites, appear to do so on somewhat questionable grounds, and their reasoning could easily be misunderstood. Thus the fact that Varsavsky (*op. cit.*) apparently succeeded in constructing admissible mass-particle trajectories connecting the Moon and the Earth does not, by any means, prove the lunar origin of the tektites or even make it probable; for any point on the Earth can be so reached from an arbitrary point of lunar surface, provided only that the initial velocity-components are appropriately chosen. As is well known, such space trajectories are governed by three simultaneous differential equations of second order; and, hence, six boundary conditions are required for complete specification. If three are set apart to specify the position of an arbitrary point of ejection on lunar surface, the remaining three can be committed to specify an arbitrary point of impact on the Earth: the initial velocity-components are then uniquely determined; but owing to the non-linearity of the underlying dynamical problem they cannot be solved for directly in terms of the selected space co-ordinates at both ends, and must be established numerically by trial and error.

The foregoing statements imply, of course, a tacit assumption that the magnitude of the initial velocity-vector is such that the surface of zero velocity of the restricted problem of three bodies, consisting of the Earth, Moon and mass-particle, is not closed around the Moon. For a mass-ratio Earth : Moon of 81·31, this will be true provided that the value of the Jacobian constant $C < 3{\cdot}188\ldots$, or that the initial launching velocity exceeds 2,322 m./sec. (as compared with the parabolic velocity of escape of 2,434 m./sec. if the Moon were alone in space. The presence of the Sun will, furthermore, diminish this velocity of escape by as much as a further 250 m./sec. above the centre of the full-moon disk). If, moreover, the Jacobian constant $C < 2{\cdot}988\ldots$ (that is, if the launching velocity exceeds 2,367 m./sec.), the surface of

zero velocity disappears completely from the orbital plane and the particle can travel to the Earth unhindered in any direction.

Now, according to Varsavsky, the tektites are lunar particles, ejected from the Moon by an impact of a meteorite, which have reached the Earth in this way; but his supporting evidence of particular trajectories connecting the terrestrial and lunar surface cannot, in the light of the foregoing remarks, claim any particular significance. The impact of a large meteorite on the Moon may indeed eject some lunar matter into outer space; but its velocity-components could not help to exhibit considerable dispersion in all directions. A minute dispersion of such velocities would, however, be sufficient to scatter widely particles impinging on as distant a target as the Earth. Perhaps the most significant fact known about the terrestrial tektites is their clustering in certain localities constituting together only a tiny fraction of the total solid surface of the Earth. This fact suggests strongly that their origin must be sought much nearer to the terrestrial surface than the Moon; and the view expressed recently by Urey[2] that this origin may be connected with the impact of cometary material appears to me to be the most satisfactory hypothesis advanced so far to this end.

Gold (*op. cit.*) conjectured also that the tektites may be formed from the same material as that constituting lunar rays around certain craters of recent (and presumably impact) origin. This suggestion should lend itself to the following direct experimental test. From a recent work of Kozyrev[3] we know that such rays on the Moon (at least around the crater Aristarchos) exhibit fairly strong luminescence in the region of 4000 A. under the impact of the aurora-producing solar corpuscular radiation. Should, therefore, the terrestrial tektites fail to exhibit a similar emission under laboratory bombardment by 50–100 keV. protons, Gold's hypothesis would have to be abandoned (or strengthened in the converse case).

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O'Keefe argues that tektites were thrown off the Moon by meteorite collisions and that they spiralled into the Earth during 10^7 years due to passage through the rare interplanetary gas and that they fall in an equatorial belt on the Earth at all points and continuously in time. Gold discusses the possible melting of the lunar materials due to meteorite collisions, but implies an acceptance of O'Keefe's arguments in regard to fall on the Earth.

Observations on tektites indicate that they occur in localized areas and that each group was distributed during a short time-interval. I have not worked on this aspect of the problem but have read the literature on the subject with some diligence. If data do not agree with our theories, do we arbitrarily ignore the data or state that they are different from those reported by competent observers?

The tektites have compositions in which silica and alumina are very prominent. Such compositions are consistent with those of some sedimentary rocks, but we can scarcely expect that the Moon was subjected to the processes that produced terrestrial sediments. Hence, it is necessary to assume that igneous processes on the Moon produced these very acid materials. In this case, the chemical processes on the Moon have differed from those on the Earth, because only rare terrestrial igneous rocks have compositions approaching those of tektites. (See R. A. Daly, "Igneous Rocks of the Earth", McGraw-Hill Book Co., New York, for analyses of igneous rocks and estimates of their relative abundances.) Terrestrial igneous rocks are often re-fused sediments, and thus even these may owe their chemical composition to sedimentary processes. The chemistry of silicate material is not completely known, and it is not possible to conclude that some new variations of silicate minerals will not occur somewhere, but a puzzling problem is not solved by referring it to a region in which the empirical chemical facts are not known. If material of the composition of tektites is generally present on the Moon, its igneous rocks are markedly different from those of the Earth.

Varsavsky reports machine calculations which can be assumed to be numerically correct although they cannot be checked, as is usual in such cases. However, he does not consider the near misses, which would be very numerous. Orbits of objects missing the Earth would be perturbed, and eventually the objects would collide with the Earth or the Moon or leave the system. Such objects reaching the Earth would be generally distributed on its surface. The special assumption that the lunar material is sprayed out in a cone of limited dimensions can scarcely be correct in view of the different velocities and the collision angles of the colliding meteorites which are to be expected. A much more extensive and thorough set of calculations will be required in order to establish his thesis that the distribution of tektites on the Earth can be explained by his postulated process.

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Calculations of Lunar Temperatures

The observations of the surface temperature of the Moon by Pettit and Nicholson[1] have led to attempts to deduce details of the lunar surface conditions. Observations of microwave radiation by Piddington and Minnett[2] were also used by Jaeger[3], but he concludes that there is an inherent discrepancy between the average temperatures determined by the two methods. The experimental results are given in Fig. 1. Jaeger, like the others quoted in his bibliography, makes the assumption in his calculations that the thermal properties of the materials remain constant.

This does not appear to be a satisfactory assumption, for Scott[4] gives evidence suggesting that the thermal conductivity of −80 mesh perlite *in vacuo* is proportional to the absolute temperature, and data in the International Critical Tables suggest that a similar relation could also apply to the specific heat. On the assumption that the conductivity and specific heat vary as the absolute temperature, let the thermal conductivity, the specific heat, the density, the absolute temperature, the distance from the

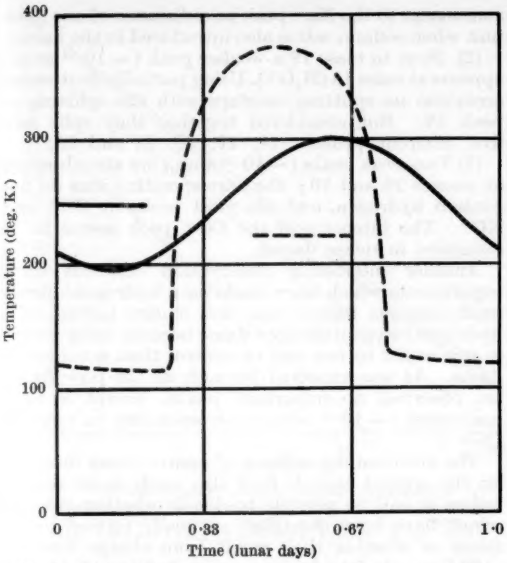

Fig. 1. Observed temperatures near lunar surface. – – –, Pettit and Nicholson (ref. 1) (average, 223° K.); ——, Piddington and Minnett (ref. 2) (average, 249° K.)

surface of the Moon and the time be kv, cv, ρ, v, x and t respectively. The heat-flow equation is:

$$\rho cv \frac{\partial v}{\partial t} = \frac{\partial}{\partial x} kv \frac{\partial v}{\partial x} \quad (1)$$

which can be rewritten:

$$\frac{\partial V}{\partial t} = \frac{k}{\rho c} \frac{\partial^2 V}{\partial x^2} \quad (2)$$

where $v^2 = V$. This implies that the average value of the temperature squared (rather than that of the temperature itself) will be constant over the first few kilometres from the surface.

Making some extrapolations from the figures by Pettit and Nicholson for temperatures at the lunar equator, and using their result that the emitted heat when the surface is illuminated is given by $E \cos^{2/3} \varphi$ (E, maximum heat emission; φ, phase angle) the average value of V is 255^2. From Piddington and Minnett the corresponding value is 252^2; that is, the corresponding averages far below the surface are 255° K. and 252° K. respectively. This agreement is well within the experimental error and could be expected to improve when more accurate values of the emitted heat are determined, since the total heat emitted (as given by the Pettit and Nicholson result) exceeds the total heat received.

On the assumption presented here it could be expected that the thermal inertia constant, $(k\rho c)^{-1/2}$, will have a value of about 200–300 at temperatures near 300° K. instead of 1,000 or more as computed by Jaeger and others. If this is the case, some revision of current theories regarding the nature of the surface of the Moon will be required.

Further studies based on the variable temperatures during a lunation and an eclipse are being undertaken and will be published later.

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Single-Hop Propagation of Radio Waves to a Distance of 5,300 km.

Experiments on the propagation of high-frequency radio waves have recently been made by Warren and Hagg[1], who have published a photographic record showing the relation between the wave frequency and the time of propagation over the 5,300-km. path between Slough and Ottawa. From this record the authors conclude that, in spite of the great distance, the 'high-angle' (Pedersen) rays were propagated by a single hop having a reflexion point midway between the terminal points.

This conclusion has been confirmed on theoretical grounds by calculations based on the Appleton and Beynon equations[2] for the reflexion of radio waves from ionospheric layers having a parabolic distribution of electron density with height. These equations, which give the length of a hop in terms of the angle of elevation of the ray and the characteristic parameters of the reflecting layer, have recently been solved for a wide range of possible conditions, for the ordinary ray in the absence of the Earth's magnetic field, using a digital computer.

Fig. 1 gives the results of these calculations for a distance of 5,300 km. It is assumed that the surfaces from which the rays were reflected were parallel to the Earth's surface, and that the true height of maximum electron density within the layer was 360 km. The ionospheric predictions issued by the Department of Scientific and Industrial Research for September 1957, when the experiment was made, show that both these assumptions are valid between about 1200 and 2020 G.M.T. for the great circle through Ottawa and Slough, and also that the critical

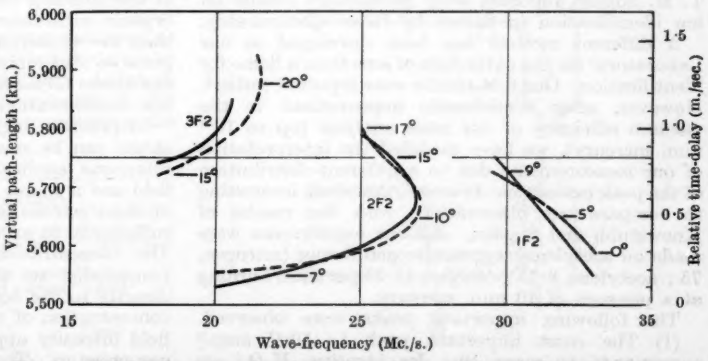

Fig. 1. Path-lengths and angles of elevation of rays arriving at Slough from Ottawa after propagation by way of a parabolic $F2$-layer. 1800 G.M.T., September 11, 1957. ——, Observed; – – –, calculated

frequency of the $F2$-layer at any point changes by only a small amount during this period.

At 1800 G.M.T. on September 11, 1957, when the record was obtained, the critical frequencies of the $F2$-layer at Slough and Ottawa were 10·5 Mc./s. and 9·9 Mc./s. respectively. Interpolation using the predicted contours of electron density gives a critical frequency of 10·3 Mc./s. at the mid-point of the path, whereas the critical frequency deduced from the record, using the Appleton and Beynon equations, is 10·6 Mc./s. The slight difference can be readily explained as a normal layer fluctuation.

Fig. 1 was obtained using the critical frequency of 10·6 Mc./s. and the true layer height of 360 km. The broken lines show the calculated trace, while the full lines show the observed trace superimposed to give the best 'fit'. The correspondence between the two sets of traces is sufficiently close to show that the application of the parabolic-layer equations to this path enables the maximum usable frequencies for each mode of propagation, and the path delay times, to be found with good accuracy.

The calculated angles of elevation of the rays in each mode of propagation are also shown on Fig. 1. This information is of obvious value in the design of aerials at the terminal points.

The solution of the Appleton and Beynon equations has also been applied to propagation over a number of other long-distance paths, and close agreement has been obtained between observation and theory. A graphical technique has been evolved for applying the equations to any path, and should prove of considerable value in solving many problems of long-distance propagation.

This work was carried out as part of the programme of the Radio Research Board, and is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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March 11.

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Ion Identification in Flames by Mass Spectrometry

In a recent communication[1], P. F. Knewstubb and T. M. Sugden reported some preliminary results on ion identification in flames by mass spectrometry.

A different method has been developed in our Laboratory[2] for the extraction of ions from a flame for identification. Our first results were reported earlier[3]. However, after considerable improvement in the vacuum efficiency of our mass analyser (up to 10^{-5} mm. mercury), we have modified the interpretation of our measurements due to a different distribution of the peak intensities. It seems, therefore, interesting to compare our observations with the results of Knewstubb and Sugden. All our experiments were made on acetylene/oxygen/nitrogen flames (nitrogen, 75; acetylene, 8·75; oxygen, 16·25 per cent) burning at a pressure of 40 mm. mercury.

The following important peaks were observed.

(1) The most important peak ($\sim 10^{-13}$ amp.) corresponds to mass 19. Its identity, H_3O^+, is shown by its splitting into four peaks with partially deuterated acetylene: 19, 20, 21 and 22 (the 22 peak comes next to the Na^+ peak at a distance of one mass unit when sodium salt is also introduced in the flame).

(2) Next to mass 19 a weaker peak ($\sim 10^{-14}$ amp.) appears at mass 18 (H_2O^+). Using partially deuterated acetylene its splitting overlaps with the splitting of peak 19. But considered together they split into five different peaks: 18, 19, 20, 21 and 22.

(3) Two weak peaks ($\sim 10^{-14}$ amp.) are also observed at masses 28 and 30; the corresponding ions do not contain hydrogen, and are most probably CO^+ and NO^+. The intensity of the CO^+ peak seems to be enhanced in richer flames.

Another interesting observation concerns some experiments which were made on a hydrogen/nitrous oxide/nitrogen flame: this was chosen instead of a hydrogen/oxygen/nitrogen flame because being yellow it was easier to run and to control than a colourless flame. As was expected for such an ion-poor flame, we observed no important peaks, except a weak maximum ($\sim 10^{-14}$ amp.) corresponding to mass 30 (NO^+).

The eventual dependence of relative peak intensity on the applied electric field also needs to be studied before it will be possible to decide whether the ions which have been identified are really formed in the flame or whether they result from charge transfer.

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Measurement of Low Vapour Concentrations by Collision with Excited Rare Gas Atoms

The ionization of gas or vapour molecules by collision with excited rare gas atoms has been studied in detail by Jesse and Saduskis[1]. Ionization occurs when the excitation potential of the rare gas is equal to, or greater than, the ionization potential of the colliding molecule. The vapours of nearly all organic substances have ionization potentials lower than the excitation potentials of the first three noble gases so that ionization by collision with excited rare gas atoms forms the basis of a method for measuring low concentrations of organic vapours.

In practice, high, steady concentrations of excited atoms can be established in a rare gas by the simultaneous application of a high-intensity electrical field and a source of free electrons. The acceleration of the electrons in the field raises their temperature sufficiently to excite the rare gas atoms by collision. The concentration of excited atoms is related exponentially to the electrical field intensity and directly to the concentration of free electrons; the concentration of rare gas ions remains low until the field intensity approaches 2,000 V./cm. at 760 mm. gas pressure. The introduction of vapour molecules into a volume of rare gas containing excited atoms leads to an increase of the ion concentration. If the

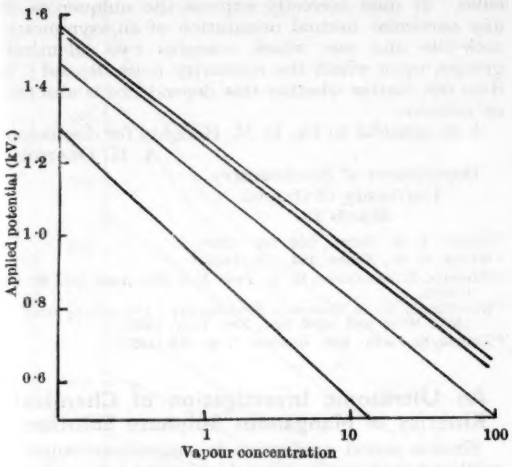

Fig. 1. The relationship between vapour concentration (c), ionization current (I) and applied potential (V) for an ionization chamber containing argon, organic vapour and a source of electrons. Values of I reading from top to bottom: ∞, 10, 1·0, 0·1

gas is contained in an ionization chamber the concentration of vapour molecules can be measured either in terms of the increase of ionization current or the decrease of potential across the chamber.

The relationship between ionization current I, applied potential V and vapour concentration c for an ionization chamber containing a mixture of rare gas vapour is as follows:

$$I = \frac{K_i c\,(x + y) + K_d x}{K_i c\,\{1 - a \exp[b(v - 1)]\} + K_d}$$

where x is the concentration of free electrons, y the concentration of excited atoms both at zero vapour concentration and K_i, K_d, a and b are constants. The relationship is illustrated in Fig. 1, which shows that for a given ionization current the logarithm of the vapour concentration is linearly related to the applied potential. The relationship is true not only for finite ionization currents but also for an infinite current, which condition is closely approximated when a spark discharge occurs across the gas. This relationship is applicable to any method of exciting rare gas atoms in the presence of vapour molecules. Those methods tried and found effective for the measurement of low vapour concentrations are listed in Table 1.

The device using a source of ionizing radiation to provide free electrons has been described in detail by Lovelock[2] and Lovelock, James and Piper[3]. Although this is sensitive, stable and simple to construct, the increasing stringency of regulations concerning the use of radioactive materials has stimulated the quest for alternative methods of exciting the rare gas atoms; of those listed in Table 1 the simplest and most effective is that based on a spark discharge operating at atmospheric pressure. Fig. 2 illustrates the electrical circuit of this device. The apparatus consists of a spark gap, width 5–10 mm., made by sealing two short lengths of platinum wire in a piece of glass tubing. In pure argon, which is the most convenient rare gas to use, sparks occur at an applied potential of 2,000 V. at atmospheric pressure. In the presence of vapour the breakdown potential falls towards 800 V. and is related logarithmically to the vapour concentration as shown in Fig. 1. Thus the very simplest apparatus consists of a spark gap and an electrostatic voltmeter connected across it to measure the breakdown potential. A linear response to vapour concentration can be obtained with the same apparatus if the spark gap is connected to a condenser and a resistance so as to function as a relaxation oscillator: this is shown in Fig. 2. The frequency of sparks across the gap is a logarithmic function of the breakdown potential and so is directly related to the vapour concentration. The signal from the spark is, of course, large and the most elementary type of frequency meter serves to indicate the vapour concentration. For the stable operation of the device it is necessary to include with it a weak source of ionization; this can be either a small quantity (about 1 μc.) of α- or β- or γ-emitting element, or a corona discharge from a subsidiary electrode. The spark device is very sensitive and responds to as little as 10^{-12} mole of most organic vapours. The spark discharge is capable of conducting large currents sufficient to operate, for example, an electromagnetic relay connected in series with it. It is a simple matter to arrange that the relay operates at any predetermined vapour concentration by choosing the appropriate applied potential for the spark gap. This type of operation would appear to have potentialities in the development of control and warning devices.

Of the other methods listed in Table 1 the next most promising is the use of a radio-frequency discharge to excite the gas and to observe photoelectrically the change in light emission when vapour is introduced. This method operates best at reduced pressures.

Table 1

Source of electrons	Method of assessing vapour concentration	Stability
Intense ionization by α, β or γ radiation	current flowing in an ionization chamber	excellent
Weak ionization by α, β or γ radiation or corona discharge	breakdown voltage of a spark gap or frequency of a spark relaxation oscillator	good
Corona discharge or silent low-pressure discharge	ionization current	poor
Radio-frequency discharge at low pressure	light emission	good

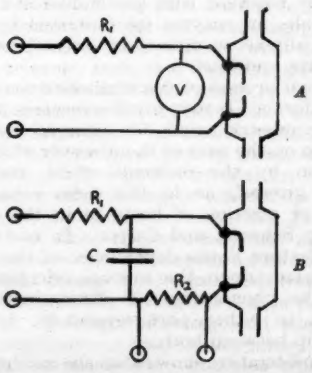

Fig. 2. Spark gap detectors. With A the vapour concentration is logarithmically related to the applied potential (V). With B the vapour concentration is directly related to the frequency of sparks. R_1, 1 megohm; R_2, 100 ohm; C, 100 pF.

Silent discharge at low pressures and corona discharge at atmospheric pressure both respond to the presence of vapour in a manner similar to the devices previously described. They suffer, however, the disadvantage that the emission of electrons from their electrodes is disturbed by the presence of vapour and it is difficult in practice to obtain consistent and reproducible operation.

The methods of vapour concentration measurement just described possess the advantages of exceptional sensitivity and freedom from disturbance by changes in ambient temperature, pressure and gas flow-rate. They are particularly suitable for use with gas chromatography apparatus.

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April 8.

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Conditions for Differential Reaction of 'Identical' Chemical Groups

Attention was first directed to the principles involved in explaining the differential reaction of two 'identical' groups in a single molecule by Ogston[1], and they have been further discussed and generalized by Wilcox[2], Schwartz and Carter[3] and most recently by Hirschmann[4]. Since a recent review[5] seems to hold that the views of these authors (in particular those of Ogston and of Schwartz and Carter) are in some ways contradictory, and since Hirschmann's excellent article appears to be too little known, a brief re-statement is attempted. Ogston's and Schwartz and Carter's views are in fact complementary (as Hirschmann shows), each being explicit about an aspect of the matter which the other takes for granted.

The molecules under discussion are all of the type in which the two 'identical' groups are so by virtue of a symmetry operation of the molecule as a whole, which changes an object into its mirror image. For example, each *a* group in the molecule C*aabd* is, in relation to the surrounding *a*, *b* and *d* groups, the mirror image of the other. However, two such enantiomorphic situations can be discriminated only by means of an asymmetric agent as, for example, an asymmetric observer who contemplates a model of the molecule, an enzyme (as discussed by Ogston), or an optically active amine in the reactions discussed by Schwartz and Carter.

The actual process of discrimination may take one of several forms. It may involve reaction or response by the asymmetric agent, for example, by a sign of recognition on the part of the observer of the model; or reaction by the molecule which contains the 'identical groups', as in the cases considered by Ogston: or reaction of both, as in the cases considered by Schwarz and Carter. In each case, the essential feature is the dependence of the reactivity of the system upon the mutual orientation of its parts. The phenomenon of discrimination is not ascribable to either part separately, but to the relationship between both.

This consideration shows that the notion of 'three-point-attachment' used by Ogston is not misleading, though it is not, of course, to be taken as a literal description of the forces acting between two molecules. It does correctly express the uniqueness of any particular mutual orientation of an asymmetric molecule and one which contains two 'identical' groups, upon which the reactivity must depend; it does not matter whether this dependence is absolute or relative.

I am grateful to Dr. D. M. Hodgkin for discussion.

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An Ultrasonic Investigation of Chemical Kinetics in Manganous Sulphate Solutions

Excess sound absorption in magnesium sulphate solutions was ascribed by Liebermann[1] to either a unimolecular or dissociation-type process involving magnesium sulphate molecules or its ions. Wilson[2] found the process to be unimolecular. Barthel[3] modified the work of Wilson and found that Wilson's work fitted equally well to the unimolecular or dissociation type process.

In order to determine the mechanism responsible for excess sound absorption in manganous sulphate the effect on sound absorption of varying the concentration of the salt and dielectric constant of the solvent has been studied. This should shift the dissociation equilibrium and so have a marked effect on sound absorption. Theoretical interpretation of the results follows that of Bies[4] for magnesium sulphate solutions.

The exact nature of the relationship between the excess sound absorption and concentration in the case of manganous sulphate is not well known, as the results of Kurtze and Tamm[5] and of Wilson differ for sound absorption in electrolytic solutions. Hence the variation with concentration of the excess sound absorption in manganous sulphate solution was studied in great detail in the range 0·0025–1 *M*. The graph of a/ν^2 against frequency (Fig. 1) shows that the absorption a/ν^2 decreases with increase in frequency. The plot of $a'\lambda$ (excess sound absorption × wave-length) against frequency reveals the existence of a relaxation frequency near 3 Mc./s., which increases in the range 0·0025–0·02 *M* but is independent of the concentration in the range 0·02–0·1 *M* and again varies slightly above 0·1 *M*.

In order to determine the mechanism responsible for excess sound absorption in manganous sulphate solutions, ultrasonic absorption in water–dioxan mixtures of dielectric constant equal to 56·5 and 48·0 e.s.u. was studied at different concentrations of manganous sulphate. Absorption was found to increase considerably with the decrease in the dielectric constant of the solvent which is also the case with $a'\lambda$. This supports the dissociation hypothesis, as the variation of the dielectric constant of the solvent should lead to the disturbance of the equilibrium in the case of dissociation reaction and influence the absorption.

In order to confirm the dissociation hypothesis further in the case of manganous sulphate, variation of the specific rate of association (K_2) with the change in the reciprocal of the dielectric constant

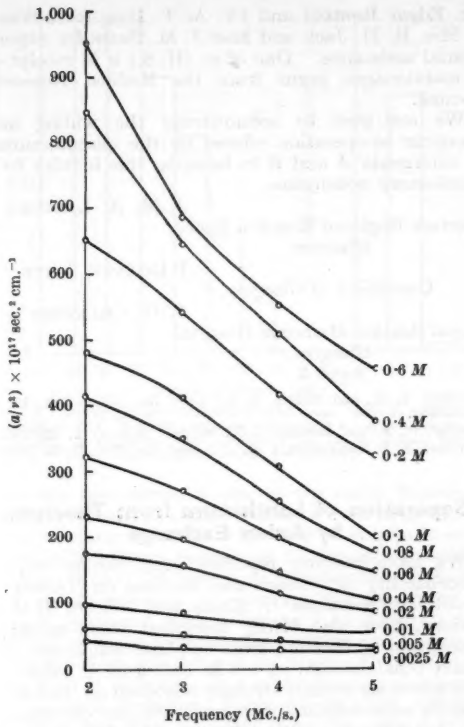

Fig. 1. Variation of absorption with frequency at various concentrations. All at 20° C.

was also studied. According to Laidler[6], this is given by:

$$-\frac{\mathrm{d}\,(\log K_2)}{\mathrm{d}\,(1/D)} = \frac{Z_1 Z_2 \varepsilon^2}{kTr} \qquad (1)$$

where $Z_1 = -Z_2 = 2$, r is equal to twice the mean ionic radius ($3{\cdot}08 \times 10^{-8}$) and ε is the electronic charge in e.s.u. In the case of ions of opposite sign, $\log K_2$ should increase with the reciprocal of the dielectric constant.

Values of K_2 for different dielectric constants are known from values of the mass action equilibrium constant (K) determined experimentally by conductivity bridge, and K_1 from acoustic measurements as $K = K_1 K_2^{-1}$. Table 1 gives the values of K, K_1 and K_2 at the different dielectric constants studied.

Table 1

D	$K \times 10^4$	$K_1/2\pi$ (Mc./s.)	$K_2 \times 10^{-3}$
78·5	50·00	2·38	2·98
56·5	30·00	2·90	6·07
48·0	21·00	3·00	8·97

As is evident from Table 1, $\log K_2$ increases with the reciprocal of the dielectric constant, confirming the dissociation hypothesis, because according to equation (1) $\log K_2$ should increase with the reciprocal of the dielectric constant. Thus it is conclusively proved that the excess sound absorption in manganous sulphate solution is due to the dissociation process.

I wish to thank Dr. G. S. Verma, under whose guidance the present investigations were carried out, and the Council of Scientific and Industrial Research (India) for the research grant.

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Arsenic in Detergents

During an investigation of the arsenic content of human hair it was discovered fortuitously that a well-known household detergent contained an appreciable proportion of arsenic. This unexpected finding arose in the following way. Since 1954 we have been studying the use of activation analysis for the estimation of arsenic in samples of hair, skin and nail and other tissues. For some elements (including arsenic) activation analysis is more sensitive than the conventional methods. It is, for example, a matter of no great difficulty to estimate the arsenic content of a single human hair in this way—a measurement which could not easily be made in any other manner.

Our first object was to measure the normal arsenic content of human hair. Small samples provided by several of our colleagues and assistants were analysed by the activation method[2]. Most of them had arsenic contents within the normal limits (less than 1 part per million). In hair from a number of female laboratory workers, however, arsenic levels up to 42 p.p.m. were found. It was thought that external contamination of the hair might have been produced by contact with arsenical compounds used in the laboratory and in the adjoining animal house. Further samples from the same subjects were cleaned by soaking overnight in detergent solution. The arsenic-levels were little changed by this treatment. As a control experiment, hair samples with normal arsenic content were subjected to the same cleaning process. On subsequent analysis these samples showed arsenic-levels up to 23 p.p.m. We then decided to investigate the arsenic content of the undiluted detergent. The method of Thomas and Collier[3] was used, with modifications in the method of digestion and chemical procedure. Estimations were made on eight detergents all in common use in industrial, scientific or domestic establishments. *A* was the detergent used to clean the hair samples already mentioned. This material, a liquid, is supplied in cans for laboratory use. *B* was another detergent offered by the same manufacturers for domestic use. We found later that *A* and *B* were of essentially the same composition. *C* was a liquid detergent for household use. *D* was a liquid detergent sold as a hair-wash. *E*, *F*, *G* and *H* were granular detergents sold in packets for domestic use. A sample of detergent *A* was obtained from a can supplied to a hospital laboratory. Samples of the other materials were obtained from bottles or packets bought in shops. The results of these analyses are given in Table 1.

Table 1

Detergent	Arsenic content (p.p.m.)
A	74
B	59
C	0·5
D	1·5
E	8
F	7
G	8·5
H	5

It was noticed that samples of materials *A* and *B*, taken from the top of a bottle which had been undisturbed for a few weeks, contained less arsenic than samples from a well-shaken bottle.

Table 2

Detergent *B*	Arsenic content (p.p.m.)
Samples from well-shaken bottle	81
After standing for one month	65
After standing for three months	47

The concentrations of arsenic in detergents *A* and *B* are surprisingly high but probably not dangerous. The analyses were made on the undiluted materials; solutions used in the laboratory or in the home would normally contain one part of detergent in 200–300 parts of water.

Many detergents include components made by the sulphation or sulphonation of hydrocarbons, alcohols or other organic substances. Arsenic might be expected in the final product if the sulphuric acid used in the manufacturing process is made by the lead-chamber process from pyrites, which very often contain arsenic as an impurity. Sulphuric acid is now generally made by the contact process in which sulphur dioxide and air are passed over a catalyst to form sulphur trioxide. The sulphur dioxide may be obtained by burning pyrites, but is carefully purified since any residual arsenic may poison the catalyst. Sulphur is, however, the more usual source of sulphur dioxide in the contact process of sulphuric acid manufacture. Sulphuric acid made by the contact process is almost free from arsenic; if made by the lead chamber method it may contain 0·1 per cent or more.

Our findings and speculations were reported to the manufacturers of detergents *A* and *B*, who took prompt and effective action to eliminate the arsenic from their products. This was done by replacing the arsenical sulphuric acid, used in the sulphation process, by acid derived wholly from sulphur.

These measures were successful, as the analyses in Table 3 show:

Table 3. Arsenic Content of Detergent *A*

Source of sample	Date obtained	Arsenic content (p.p.m.)
Hospital laboratory	October 1956	74
Manufacturer	August 21, 1957	19
Hospital laboratory	August 29, 1957	25
Manufacturer	October 18, 1957	1·9
Manufacturer	October 25, 1957	0·6
Hospital laboratory	January 1958	1·6

It remains to explain the curious findings which initiated the inquiry now reported. The washed samples of hair had clearly absorbed arsenic from the detergent solutions applied in the hope of cleaning them. The high arsenic levels in untreated hair from the female laboratory workers are attributable to the practice of washing the hair with undiluted detergent and failing to rinse adequately.

We are grateful to the members of the Isotope Division, Atomic Energy Research Establishment, Harwell, for the experimental irradiations of hair samples; to Prof. J. Glaister and Dr. P. R. Peacock for laboratory facilities; to Prof. P. D. Ritchie, Dr. Edgar Rentoul and Dr. A. T. Doig for advice; to Mrs. R. H. Jack and Miss J. M. Bates for experimental assistance. One of us (H. S.) is in receipt of a maintenance grant from the Medical Research Council.

We are glad to acknowledge the willing and energetic co-operation offered by the manufacturers of detergents *A* and *B* in bringing this inquiry to a satisfactory conclusion.

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Separation of Lanthanum from Thorium by Anion Exchange

We have recently reported some results on the adsorbability of yttrium and thorium on 'Dowex 1' in sulphate solutions[1,2]. Kraus and Nelson, in their review[3], have also briefly described anion-exchange adsorption of thorium from sulphate solutions. We found that thorium in 0·1 *M* and 0·01 *M* sulphuric acid solutions is fairly strongly adsorbed on 'Dowex 1' and its adsorbability increases with the decrease in the concentration of sulphuric acid. On the other hand, yttrium in such solutions is only slightly adsorbed on 'Dowex 1'. This fact suggested to us that it might be possible to separate thorium from some rare earth elements by anion exchange. This communication describes the anion exchange behaviour of thorium in sulphuric acid solution and the separation of lanthanum from thorium by anion exchange.

The resin used throughout this study was 'Dowex 1-*X*8' in sulphate form, consisting of 100–200 mesh beads. The experiments on the adsorption and desorption of thorium to and from 'Dowex 1' were carried out as follows. 1 gm. of resin was placed in a glass column 8 mm. in diameter and washed thoroughly with 0·02 *M* sulphuric acid. A solution of *p*H 2·4, which was 0·0086 *M* in Th^{4+} and 0·020 *M* in sulphuric acid, was then allowed to pass through the column at a flow-rate of 0·3 ml./min. 10-ml. fractions of the effluent were successively collected and thorium in each fraction was determined to estimate the percentage of thorium adsorbed on the resin. The uptake of thorium on 'Dowex 1' from sulphuric acid solution is good, and complete recovery of thorium in the effluent is achieved by the elution with 1 *M* sulphuric acid (Fig. 1, Table 1). Jenkins and Richardson reported difficulty in the elution of thorium adsorbed on 'Deacidite *FF*' from a solution containing uranium, thorium, nitrate and sulphate[4]. In our process, however, no difficulty was encountered in the removal of thorium from the bed of 'Dowex 1'.

For experiments on the separation of lanthanum from thorium, commercial thorium salt was purified to separate thorium and radiothorium from their decay products. Then two series of experiments were carried out as follows.

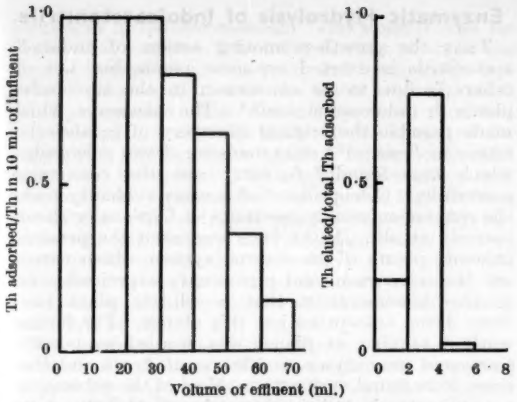

Fig. 1. Adsorption and desorption of thorium. Sample solution: 0·0086 *M* Th^{4+}, 0·02 *M* sulphuric acid, *p*H 2·4. Resin column: 1·0 gm. of sulphate resin 'Dowex 1-X8' in an 8-mm. tube. Flow-rate at elution, 0·3 ml./min.

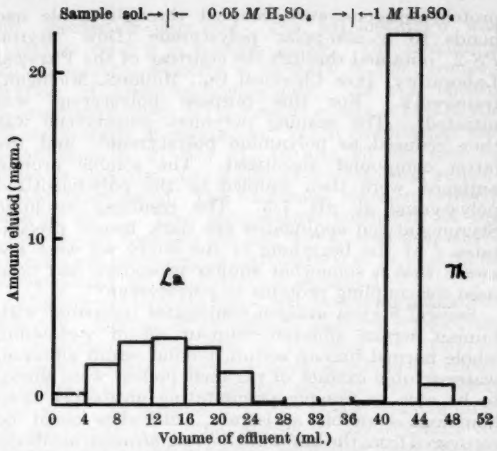

Fig. 2. Elution of lanthanum and thorium. Sample solution: 23·2 mgm. Th^{4+} and 16·5 mgm. La^{3+} in 0·05 *M* sulphuric acid. Resin column: 3·0 gm. of sulphate resin 'Dowex 1-X8' in an 8-mm. tube. Flow-rate at elution, 0·3 ml./min.

In the first series, 3 gm. of the same 'Dowex 1' resin was placed in a glass column 8 mm. in diameter. After washing the resin with 0·05 *M* sulphuric acid, 15 ml. of a solution containing 23·2 mgm. of purified thorium (Th^{4+}), 16·5 mgm. of pure lanthanum (La^{3+}) and small amounts of thorium-234 as tracer in 0·05 *M* sulphuric acid (solution *A* in Table 2) was allowed to pass through the column at a strictly regulated flow-rate of 0·3 ml./min. Upon elution with 0·05 *M* sulphuric acid all lanthanum present in the original solution appeared in the effluent. Thorium was then removed from the resin bed by elution with 1 *M* sulphuric acid. Fig. 2 represents a typical elution histogram, indicating clear separation of lanthanum from thorium. The results in Table 2 show that the recovery of lanthanum and thorium in the effluent is complete, and no contamination with thorium occurs in the lanthanum fraction as indicated by measurements of radioactivity. In the second series of experiments, the composition of influent solution (solution *B* in Table 2) was the same as in the first series except that the solution contained lanthanum-140 tracer instead of thorium-234. The introduction of the solution into the column and subsequent elution were performed in the same way. The results in Table 2 indicate that the contamination of thorium fraction by lanthanum is negligibly small.

Table 1. Adsorption and Desorption of Thorium

Run	Uptake of thorium: around break-through	at saturation	Recovery of thorium by elution with 1 *M* sulphuric acid
1	60 mgm.	91 mgm.	90 mgm.
2	60 mgm.	96 mgm.	95 mgm.
3	60 mgm.	94 mgm.	—

Table 2. Anion Exchange Separation of Lanthanum from Thorium

Solution *A* (thorium-234 tracer)				
Run	Recovery of lanthanum in effluent (mgm.)	Thorium-234 in lanthanum fraction (c.p.m.)	Recovery of thorium in effluent (mgm.)	Thorium-234 in thorium fraction (c.p.m.)
1	16·5	6 ± 3	23·0	18,895 ± 140
2	16·2	0 ± 2	23·7	15,667 ± 90
3	16·5	0 ± 2	23·3	15,779 ± 90
Solution *B* (lanthanum-140 tracer)				
Run	Recovery of lanthanum in effluent (mgm.)	Lanthanum-140 in lanthanum fraction (c.p.m.)	Recovery of thorium in effluent (mgm.)	Lanthanum-140 in thorium fraction (c.p.m.)
1	16·5	5,208 ± 45	23·5	12 ± 6
2	16·4	3,098 ± 45	22·9	8 ± 6

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Isolation of Antibodies on Antigen–Polystyrene Conjugates

The isolation of precipitating antibodies in a purified form has been the subject of several investigations during the past few years. The property of the specific combination of antibodies with their homologous antigens has been exploited for this purpose. In principle, a general procedure for the isolation of antibodies would involve the following steps: (1) formation of insoluble antibody–antigen complexes, (2) dissociation of these complexes, and (3) separation of the purified antibodies from the antigen(s). Obviously, the last step would be facilitated if the antigen were insoluble or could be made insoluble by coupling it *via* stable covalent chemical bonds to a supporting medium. For example, in previous investigations protein antigens were coupled to fibrinogen[1], ion-exchange resins[2] and cellulose[3]. Since these supporting media were endowed with ion-exchange properties, it is conceivable that serum proteins may be bound to them non-specifically. In order to avoid or at least to minimize non-specific absorption of serum proteins, in the present study,

protein antigens were coupled through stable azo bonds to a non-polar polystyrene (Dow 'Styron *PS*-2', obtained through the courtesy of the Physical Laboratory, Dow Chemical Co., Midland, Michigan) framework. For this purpose polystyrene was nitrated[4]. The ensuing polynitro polystyrene was then reduced to polyamino polystyrene[4,5] and the latter compound diazotized. The soluble protein antigens were then coupled to the polydiazotized polystyrene at *p*H 7·5. The resulting insoluble Styron–antigen conjugates are dark brown precipitates. At the beginning of the study we were not aware that a somewhat similar procedure had been used for coupling proteins to polystyrene[1,7].

Several Styron–antigen conjugates (prepared with human serum albumin, human serum γ-globulin, whole normal human serum, bovine serum albumin, water-soluble extract of ragweed pollen) were shown to be able to remove precipitating antibodies from homologous rabbit antisera. Antibodies could be recovered from the insoluble Styron–antigen–antibody complexes by dissociation with hydrochloric acid at *p*H 3. These antibodies retained their immunological specificities, that is, they were precipitable with homologous antigens and were soluble in antigen excess. The specificity of the method was also borne out by the fact that antisera were not depleted of their antibodies by conjugates prepared with heterologous antigens.

Styron-ragweed conjugates were also shown to be capable of removing completely skin-sensitizing and blocking antibodies from sera of ragweed-sensitive individuals. This is taken as evidence that firm combination does occur between these antibodies and the ragweed allergens. On the other hand, these antibodies were not removed by heterologous Styron–antigen conjugates, demonstrating thus the specificity of the combination between these antibodies and the appropriate allergens.

The details of the whole experimental procedure and the physico-chemical and immunochemical characterization of antibodies isolated by the use of Styron–antigen conjugates will be described elsewhere[8].

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Enzymatic Hydrolysis of Indoleacetonitrile

That the growth-promoting action of indole-3-acetonitrile is exerted on some plants but not on others is due to its conversion in the susceptible plants to indoleacetic acid[1,2]. The bioassays which made possible the original discovery of indoleacetonitrile in *Brassica*[3,4] were made on *Avena* coleoptiles, which were found[1,2] to carry out the conversion powerfully. Coleoptiles of *Zea mays* evidently make the conversion weakly, seedlings of *Lupinus* or *Pisum* scarcely at all[1]. These facts suggested the presence in some plants of an enzyme system which carries out the conversion, and preliminary experiments led to the demonstration that a cell-free plant juice from *Avena* coleoptiles has this ability. For further work a number of plants was studied as possible sources of the enzyme, and leaves of *Avena* and *Hordeum* were found very active. Most of the subsequent experiments, including those described here, have been made with barley leaves and stems, Breck's six-row variety. The activity was assayed by incubating the juice with a known quantity of synthetic indoleacetonitrile for 4 hr., then acidifying the solution to *p*H 2·8 with H_3PO_4, shaking out with ether, treating the ethereal solution with saturated sodium bicarbonate and acidifying the latter and re-extracting. The ether extract was taken up in water and its indoleacetic acid content determined by the Salkowski reaction[5]. Earlier experiments had shown good agreement of the Salkowski indoleacetic acid determinations with results obtained from pea curvature and pea straight-growth bioassays, and with estimates from paper chromatograms.

The results show that the activity of the juice is destroyed by boiling, can be precipitated from the solution with ammonium sulphate or with acetone, and on dialysis remains within the dialysis bag. It is not brought down by centrifuging at 10,000*g* for 25 min. It is therefore considered to be a soluble enzyme, and will be provisionally termed 'indoleacetonitrilase'.

Table 1. Action of Indoleacetonitrilase in 4 hr. at 25° C. and *p*H 7·0. Indoleacetonitrile Added, 250*γ* per Tube

Treatment	Indoleacetic acid formed, *γ*
None (in air)	19·5
Solution evacuated	19·0
Iodoacetamide 10^{-3} *M**	20·8
Phenylmercuric nitrate 10^{-4} *M**	18·5
Boiled (1 min.)	0

* Final concentration

Some properties of the enzyme are shown in Table 1. They show that its activity is not dependent on a sulphydryl group, and, more important, is as great *in vacuo* as in air. If, therefore, the action is a hydrolysis, it is believed to be the first such hydrolysis so far described. A series of experiments with a single enzyme preparation at different concentrations of indole-3-acetonitrile gave a value for the Michaelis constant, K_m, of 7×10^{-5} *M*. Other experiments have shown conversions of the nitrile to the acid as large as 60 per cent.

The expected intermediate in the hydrolysis would be indoleacetamide:

$$Ind\text{CH}_2\text{CN} \xrightarrow{H_2O} (Ind\text{CH}_2\text{CONH}_2) \xrightarrow{H_2O} Ind\text{CH}_2\text{COOH} + \text{NH}_3$$

where *Ind* represents the indole nucleus. However, it was noted previously with whole *Avena* coleoptiles that the chromatography yielded no evidence for the

formation of indoleacetamide. The same is true for the soluble enzyme; when the reaction product was chromatographed no spot for indoleacetamide appeared. However, because the amide might be more rapidly attacked than the nitrile, and thus not accumulate, a study was made of the action of the enzyme on the synthetic amide. In this case, acid formation, as estimated from paper chromatograms, was less than 5 per cent of the amount formed from the nitrile. No acid formation was noted by the Salkowski estimation, but indoleacetamide carried over interferes with this procedure. It is concluded that the free amide is not an intermediate in the reaction, and that the enzyme attacks indoleacetamide weakly, if at all.

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Phosphomannoisomerase, an SH-Dependent Metal-Enzyme Complex

PHOSPHOMANNOISOMERASE was found in red cells of the pig. The enzyme catalyses the reaction

mannose-6-phosphate ⇌ fructose-6-phosphate

Enzyme activity was determined by measuring the rate of formation of fructose-6-phosphate. The method was as follows: 1 vol. packed cells + 4 vol. ice-cold distilled water were frozen and thawed several times. 1·0 ml. of this hæmolysate, corresponding to 0·2 ml. original packed cells, 1·0 ml. acetate buffer, 0·1 *M*, *p*H 5·6, and 1·0 ml. mannose-6-phosphate (sodium salt 0·03 *M*, *p*H 5·9) were kept at 37° C. for the appropriate time and deproteinized by the addition of 3·0 ml. ice-cold 10 per cent perchloric acid. The deproteinizing agent was added to the blank before mannose-6-phosphate. The method of Roe[1] was chosen for the determination of fructose-6-phosphate in the filtrates. Because of the big excess of phosphoglucoisomerase in red cells[2] the fructose-6-phosphate measured is in equilibrium with glucose-6-phosphate at any stage of the reaction (60 and 40 per cent of glucose-6-phosphate and fructose-6-phosphate respectively at 37° C.). This was confirmed by determinations of glucose-6-phosphate with triphosphopyridine nucleotide and Zwischenferment[3] and colorimetric measurements of fructose-6-phosphate in corresponding filtrates. The total original amount of fructose-6-phosphate was calculated by multiplication of that found by 2·5.

The method of measurement of enzyme activity was adapted to optimum conditions. The conversion of mannose-6-phosphate proceeds linearly with time until about 50 per cent of the substrate has been isomerized. There is also a linear dependence on enzyme concentration up to 80 μl. lysed red cells per ml. incubation mixture. The *p*H optimum was found to be 5·9 in acetate buffer. The maximum initial reaction velocity is at 0·03 *M* final concentration of mannose-6-phosphate. At the chosen concentration (0·01 *M*) the reaction-rate is two-thirds of the velocity at saturation. When equilibrium was established at 37° C., 31, 46 and 23 per cent of fructose-, glucose- and mannose-6-phosphate, respectively, were found. The maximum reaction velocity was at 46° C. The temperature coefficient in the linear range between 30° and 40° C. was 3·0, corresponding to an energy of activation *A* of 21 kcal./mole as calculated by the Arrhenius equation.

The enzyme requires free —SH groups for maximum activity. Inhibition by organic mercury compounds (*p*-chloromercuribenzoate) is reversed by cysteine. Monoiodoacetate or arsenite have no inhibitory effect. Enzyme activity is completely abolished by addition of 1×10^{-4} *M* versene, 5×10^{-3} *M* *o*-phenanthroline, or α,α′-dipyridyl. The degree of reactivation by divalent metal cations after inhibition with versene may be seen from Table 1. Undialysed hæmolysates generally are not activated by the addition of metal salts.

Table 1. REACTIVATION BY DIVALENT METAL CATIONS OF PHOSPHOMANNOISOMERASE INHIBITED WITH VERSENE

Versene concentration*	Metal ion	Concentration	Reactivation of original activity (per cent)
1×10^{-4} *M*	Mg^{++}	5×10^{-4} *M*	25
1×10^{-4} *M*	Ca^{++}	5×10^{-4} *M*	100
1×10^{-3} *M*	Mn^{++}	2×10^{-3} *M*	50
1×10^{-4} *M*	Fe^{++}	1×10^{-4} *M*	90
1×10^{-4} *M*	Co^{++}	5×10^{-4} *M*	90
1×10^{-3} *M*	Ni^{++}	5×10^{-3} *M*	no reactivation
1×10^{-3} *M*	Cu^{++}	5×10^{-3} *M*	130
1×10^{-4} *M*	Zn^{++}	1×10^{-4} *M*	95
1×10^{-4} *M*	Cd^{++}	1×10^{-4} *M*	no reactivation†
1×10^{-4} *M*	Hg^{++}	1×10^{-4} *M*	no reactivation†

* The versene concentrations selected inhibited the enzyme action completely.
† Cd^{++} and Hg^{++} are inhibitors in the absence of versene.

These results indicate that phosphomannoisomerase is an SH-dependent metal-enzyme complex. The metal specificity is not very sharp, as has been found for other metal-dependent enzymes[4–6]. Most of the metal ions tested belong to the first transition series of the periodic system. They differ little in atomic weight, ionic radius and potential, mobility, etc., and have equal charges. Furthermore, their 3*d* electron orbitals are not completely filled and they form complexes by covalent linkages between the metal and the bound groups. This formation of complexes is important in understanding the reaction mechanism of phosphomannoisomerase. Substrate specificity of the enzyme against mannose-6-phosphate is partially given by the metal-dependent mechanism of binding. On the other hand, phosphoglucoisomerase is not inactivated by *p*-chloromercuribenzoate or versene. So the mechanisms of mannose- or glucose-6-phosphate formation from fructose-6-phosphate by the isomerases, with the formation of the *cis*-enediol or *trans*-enediol intermediates[7,8] are quite different.

A mannoisomerase was described by Slein[9]. He did not find any requirement for metal ions in his preparations of rabbit muscle. However, all his activation experiments seem to have been carried out at *p*H 7·4 and not at the optimum. We also found only slight inactivation by versene at *p*H 7·4. Furthermore, the high metal concentrations (0·01–0·04 *M*) used by Slein denaturated our enzyme completely. Work now in progress will establish

whether or not the enzymes investigated by Slein and by us are identical.

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Cytochrome System in Oyster Tissues

Although some experiments with tissue extracts of the oyster have proved the presence of an oxidase very similar to the cytochrome oxidase of higher animals[1,2], it is still obscure whether the cytochrome system functions as terminal oxidase in the intact tissues of oysters, because even cytochrome has not been observed spectroscopically. Recently, Jodrey and Wilbur[2] suggested that the cytochrome system may not play a major part in the oxidative metabolism of the oyster mantle (*Crassostrea virginica*), since methylene blue ($1{\cdot}4 \times 10^{-5}$ *M*) did not reverse the cyanide inhibition of the tissue.

In the present investigation, absorption bands of the cytochromes were observed with the tissue homogenate of the oyster (*Crassostrea gigas*), when reduced with hydrosulphite, by applying the liquid-air method of Keilin and Hartree[3]. The absorption bands, however, were very faint compared with those of baker's yeast. The band corresponding to cytochrome *b* (560–565 mμ at room temp., 560 mμ at liquid-air temp.) was detected in all tissues examined, namely, gill, mantle, adductor muscle and digestive diverticula. However, the band *a* (around 600 mμ) was observed only in the gill and the mantle, and no trace of cytochrome *c* was detected. A very strong pyridine hæmochromogen band (550–560 mμ) was readily obtained with all tissues.

In a gas mixture of 90 per cent nitrogen and 10 per cent oxygen, the respiration of both the mantle and the gill was inhibited by about 50 per cent in the dark, and this inhibition was reversed almost completely by illumination with a 500-watt lamp (Table 1).

The respiration of both the mantle and the gill was also reduced by 0·001 *M* cyanide to about 18 per cent of the control value. In the presence of a nearly saturated solution of methylene blue in sea water (6×10^{-5} *M*), the inhibition was reversed to about 40 per cent; it was confirmed that a lower concentration of methylene blue (1×10^{-5} *M*) did not reverse the cyanide inhibition.

From these experiments it is evident that the respiration of the oyster tissues is largely dependent on metabolic pathways involving the cytochrome–cytochrome oxidase system. The fact that no band of cytochrome *c* was detected in any tissue examined, or of cytochrome *a* in certain tissues of the oyster, may be attributed to the low concentration.

Table 1

Tissue	Time (min.)	Oxygen uptake (μl.)*	
		90 per cent nitrogen + 10 per cent oxygen†	90 per cent carbon monoxide + 10 per cent oxygen
Mantle slices, 100 mgm. wet weight	0–40	31	11, dark
	40–80	29	26, light
	80–120	28	14, dark
	120–160	26	26, light
Gill pieces, 50 mgm.	0–50	34	18, dark; 34, light
	50–100	31	30, light; 17, dark

* The oxygen uptake was measured in Warburg manometers, with vessels about 9 ml. capacity, at 25° C. The vessels contained 1·5 ml. of 0·03 *M* glycine or glycylglycine-buffered sea water (*p*H 8·0) and 50 or 100 mgm. of tissue pieces.
† There was no difference between oxygen uptake in this mixture and in air.

Details of this work will be published elsewhere.

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Structure of Sperm- and Sei-Whale Insulins and their Breakdown by Whale Pepsin

As described in previous papers[1], our experimental results, using the method of Moore and Stein[2], have shown that the amino-acid composition of whale (sei-) insulin differs from that reported by Sanger *et al.*[3]. Furthermore, we have recently re-examined the amino-acid analyses of sperm- and sei-whale insulins (whole insulin and both glycyl (*A*) and phenylalanyl (*B*) chains of oxidized insulin, respectively). These experiments have confirmed that the amino-acid content of sperm insulin is similar to that obtained by Sanger *et al.*; but sei-whale insulin contains an alanine instead of an *iso*leucine residue in the *A* chain.

The amino-acid sequences in both sperm- and sei-whale insulins were then compared with the sequence reported by Sanger *et al.* The *B* chains were found to have the same sequence as Sanger's, but there were species differences in positions 8–10 of the *A* chain: in sperm insulin, Thr.Ser.Ileu (identical with Sanger), and in sei-whale insulin, Ala.Ser.Thr.

Crystalline sperm- and sei-whale insulins[4], and crystalline sei-whale pepsin[5], which we have previously prepared and described, were recrystallized 4 and 7 times respectively. Crystalline swine pepsin was obtained from the Worthington Chemical Laboratory and recrystallized four times. Pepsin was used in a glycerol solution containing 10 mgm. per ml. The oxidation and fractionation of insulin, and the partial hydrolyses of each fraction with both pepsins or hydrochloric acid were carried out under the conditions described by Sanger *et al.*[3]. The hydrolysates were fractionated by paper ionophoresis at *p*H 3·2 or 6·5 (pyridine–acetate buffer), and paper chromatography with phenol/ammonia and also *n*-butanol/acetic acid solvent mixtures. The peptides were eluted and the eluates hydrolysed with 6 *N* hydrochloric acid and the constituent amino-acids identified by paper chromatography. From a comparison between the amino-acid composition of these peptides and the known sequence of amino-acids in the *A* and *B* chains of beef insulin, it was possible to assign positions to

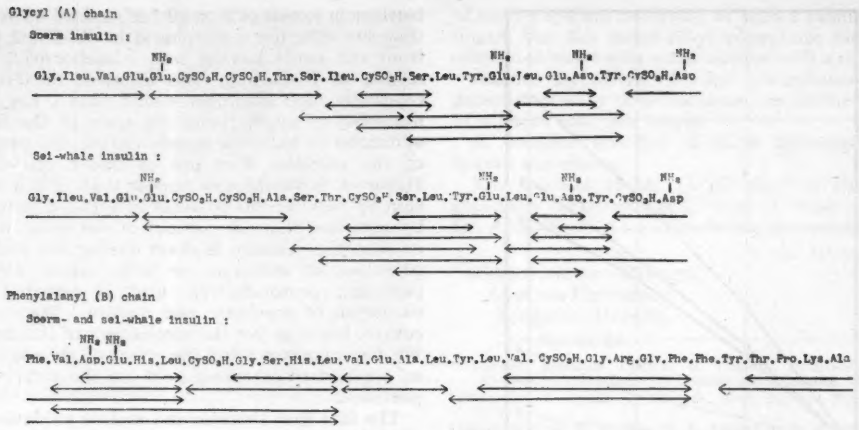

Fig. 1. The amino-acid sequence of sperm- and sei-whale insulins and peptides formed by hydrolysis of whale pepsin at *p*H 2·0, 37° C., for 48 hr.

each amino-acid. These results are summarized in Fig. 1.

Thus, sei-whale insulin is proved to differ from sperm insulin (which is the same as swine insulin as reported by Sanger), in that an *iso*leucine residue is replaced by an alanine and the three residues in positions 8–10 of the *A* chain are Ala.Ser.Thr.

On the other hand, it will be seen that there are some differences between the peptide bonds split by whale and swine pepsin, although many of the sites are the same. In the control experiments it was shown that the points of attack of swine pepsin on the *B* chain agreed with the findings of Sanger in his work[6] on the action of swine pepsin, whereas the points on the *A* chain were different from his results[7] on beef insulin, showing additional splitting at the positions *A*11–12, *A*18–19, and *A*19–20.

Whale pepsin was found to be an enzyme with a specificity somewhat different from that of swine pepsin. On the whole, it seems that whale pepsin specifically attacks many of, but not all, the peptide bonds in which valine is the amino partner and leucine is the carboxyl partner. Also both sides of a serine residue (except the position *A*12–13 in sei-whale insulin) are broken. The unbroken serine bond in the *B* chain is situated next to the basic amino-acid. Besides this, many other bonds are broken down less specifically.

Full details of this and other work on the specificity of pepsins of various whales (sperm-, fin- and sei-) and seals will be published elsewhere.

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Activity of Cytoplasmic Particles isolated from Apples

Lieberman[1] has recently described the difficulty experienced in obtaining from apples cytoplasmic particles having enzymatic activity ; he found it necessary to homogenize his apple tissue in *tris* buffer at *p*H 9·2 in order to obtain particles with appreciable cytochrome oxidase activity. Hulme[2] has previously found it necessary to use alkaline buffers to extract enzymes from apple tissue.

For some time now, we have been endeavouring to obtain active particles from several varieties of English apples by the general methods described in the literature for the isolation of mitochondria from plants. Briefly, the fruit was peeled, cut into cubes and extracted with 0·4 *M* sucrose buffered to *p*H 7 with 0·5 *M* phosphate (various concentrations of phosphate have been tried). Extraction was carried out either (*a*) by grinding with silver sand in a pestle and mortar cooled to −10° C., or (*b*) in a Waring-type blendor. A small amount of sodium hydroxide was carefully added if necessary during extraction to keep the *p*H of the medium between 6·8 and 7·0. Extraction was rapid, and the tissue mush was then pressed through four layers of cheese cloth and this was followed by centrifugation at 1,000*g* for 5 min. The supernatant liquid was centrifuged at 24,000*g* for 15 min. The orange-brown coloured pellets on the bottom of the centrifuge tubes were resuspended in the sucrose–phosphate medium using a rotary glass homogenizer. The liquid was again centrifuged at 24,000*g* and the process repeated. The residue was finally suspended in a small amount of 0·2 *M* sucrose and 0·025 *M* phosphate to give the particulate suspension ('particles') used in the experiments described below. All the preliminary manipulations described above were carried out at 1° C. and the refrigerated centrifuge was set at 0° C.

The particles from either Bramley's Seedling or Cox's Orange Pippin apples had no activity whatever when examined with various acids of the tricarboxylic acid cycle in a Warburg respirometer at 30° C. The addition of the usual co-factors (adenosine triphosphate, cytochrome *c*, hexokinase, diphosphopyridine nucleotide, yeast concentrate, magnesium sulphate, manganese sulphate) produced no activity, neither did modifications of the concentrations in the extrac-

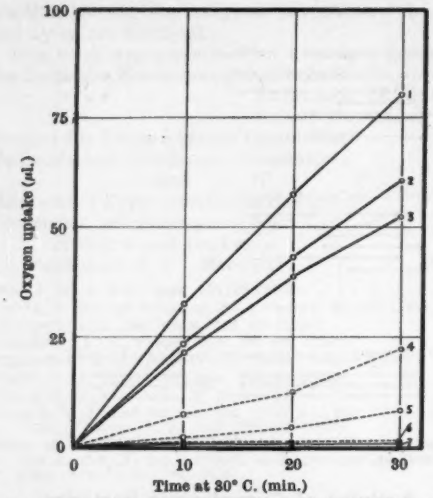

Fig. 1. The oxygen uptake of various substrates added to apple particles: (1) succinate and protocatechuate; (2) malate and protocatechuate; (3) protocatechuate; (4) succinate and protocatechuate; (5) protocatechuate; (6) malate or succinate; (7) 'boiled' particles used with succinate and protocatechuate. (1), (2), (3), and (7), Particles from tissue ground with sand. (4), (5) and (6), Particles from homogenized tissue

tion medium used to prepare the particles nor the addition of reducing agents (ascorbic acid, cysteine) to this medium.

In the course of the work, however, it was noticed that if the final (washed) particles, and the second supernatant liquid (first supernatant from centrifugation at 24,000*g*, above) were mixed, before being placed in the Warburg flasks, both browning and oxygen uptake occurred (when added separately, no changes occurred). It thus appeared that polyphenolase activity was associated with the particles but that browning occurred only on addition of phenolic substrates present in the supernatant. Bonner[3] has reported polyphenolase to be located in particulate fractions of mushrooms and etiolated mung bean seedlings. Experiments with phenolic substrates with and without the simultaneous addition of succinate and malate were next tried; results with protocatechuic acid are shown in Fig. 1. The upper set of three curves are for particles obtained by grinding with sand, the lower set of curves for particles prepared by homogenization in a blendor. In all cases the reaction mixture in the Warburg flasks was: 0·1 *M* sucrose, 0·0125 *M* phosphate, 10^{-3} *M* magnesium sulphate, 10^{-3} *M* manganese sulphate, 1 mgm. adenosine triphosphate, 1 ml. particulate suspension (equivalent to 66 gm. of fresh tissue), 0·01 *M* protocatechuic acid (or water), 0·025 *M* malate or succinate (or water). Total volume, 2 ml.; *p*H, 7·0. Only the substrate additions are named in the legends of the figure.

As a comment on the lower activity of the preparations from homogenized tissue, it is a well-known fact that a blendor run at full speed tends to tear apart mitochondria; hence the results support the suggestion of Bonner[4] that, in plants containing phenol oxidase, the ratio of soluble to bound phenol oxidase can serve as an index of the integrity of isolated cytoplasmic inclusions.

Lieberman and Biale[5] have shown that the activity of mitochondria prepared from the sweet potato is inhibited by concentrations of catechol at concentrations in excess of 3×10^{-3} *M* and we have thought that the difficulty experienced in obtaining particles from the apple having true mitochondrial activity might, as Lieberman[1] has inferred, be due to the relatively high chlorogenic acid (and other phenolic material) of apple tissue—in spite of the fact that additions of reducing agents during the preparation of the particles does not overcome the difficulty. However, it would now appear that, if this inactivation by polyphenols operates in apple, then it is either because the phenolic content of the tissue is so high or that the damage is done during the preliminary processes of isolation, or both, since, with apple particles, protocatechuic acid is essential to the oxidation of succinate and malate. We do not, of course, know as yet the mechanism of this oxidation. We have not yet tried the effect of chlorogenic acid, as opposed to catechuic acid, on the activity of our particles.

The fact that succinic and malate oxidation occurs only in presence of protocatechuic acid provides a possible explanation of the fact, reported by Neal and Hulme[6], that post-climacteric apple tissue will not oxidize malate in absence of oxygen although no oxygen uptake occurs when malate is oxidatively decarboxylated in air. Bonner[4] has suggested that the role of phenol oxidation in plant respiration should be evaluated in terms of electron transport in anaerobic systems and that phenol oxidase could function in electron transport to cytochrome *c* in mitochondria.

In view of the absence of free succinate from normal apple tissue[6] it is interesting that succinate added to the particles with protocatechuate gives (Fig. 1) a greater oxygen uptake than the addition of malate.

The work described in this communication was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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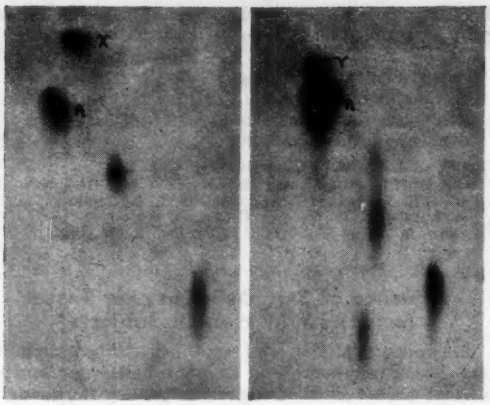
Formation of Alkyl Phosphates in Wheat Leaves

The phosphorylated compounds in leaves of Thatcher wheat plants have been studied after supplying radioactive orthophosphate (phosphorus-32). After killing, extraction of the leaves with boiling alcohol, and evaporation of the extracts to small volume, aliquots were fractionated according to the procedure of Runeckles and Krotkov[1], involving ionophoresis and paper chromatography. In addition to several of the commonly occurring phosphate esters, several radioactive unknowns were detected on subsequent autoradiograms. This communication deals with the identification of two of these compounds.



A *B*

Fig. 1. Separation of compounds labelled with phosphorus-32 from wheat leaves. *A*, Extracted with ethanol; *B*, extracted with methanol. The origin in each case is at the bottom right of the figure

When boiling ethanol was used as killing agent, the spot labelled *X* in Fig. 1*A* was invariably found to be present. When boiling methanol was used, however, this spot no longer appeared, but another compound consistently occurred at a position closer to orthophosphate (Fig. 1*B*, *Y*).

The dependence of the occurrence of these compounds upon the alcohol used for extraction suggested that they were alkyl phosphates. Accordingly, co-chromatographic studies were carried out on these two unknowns after mixing with authentic mono-, di-, and tri-methyl and ethyl phosphates. Spot *X* was found to co-chromatograph exactly with mono-ethyl phosphate, and spot *Y* with the mono-methyl ester.

Both unknowns were found to be very resistant to hydrolysis in *N* sulphuric acid at 100° C. Breakdown, as determined by radioactivity measurements on the reaction products after their chromatographic separation, was less than 5 per cent after 4 hr. This is in keeping with the known stability of the alkyl phosphates[2]. Neither di- nor tri-alkyl phosphate could be demonstrated in the extracts.

In an experiment on the rates of incorporation of phosphorus-32 into various organic phosphates in the light, in which ethanol was used to kill the leaf tissue, the total activity present as ethyl phosphate increased rapidly for five minutes from the time of vacuum infiltration of the leaf tissue with orthophosphate, and thereafter increased more slowly. At the same time, the total activity-levels of adenosine triphosphate were consistently lower than those of both ethyl phosphate and adenosine diphosphate, suggesting a possible mechanism for the formation of alkyl phosphate by transfer of phosphate from adenosine triphosphate:

$$R\text{—O—H} + \text{ATP} \rightarrow R\text{—O—P} + \text{ADP}$$

Since only the ester corresponding to the alcohol used for killing could be detected in any leaf extract, these compounds must be regarded as artefacts arising immediately prior to the death of the leaf cells. However, since no esterification occurred on boiling orthophosphate with alcohol in the absence of leaf material, their formation does indicate the presence of a suitable catalytic system. No record of such a system occurring in higher plants has been found, but the mono-ethyl phosphate formed from ethanol in yeast cells could involve such a mechanism[3].

Similar formation of alkyl phosphates has been demonstrated by their occurrence in alcoholic extracts of tobacco and pea leaves.

A detailed account of these investigations will appear elsewhere.

The interest of Dr. G. Krotkov in this work is gratefully acknowledged, and I wish to thank Dr. A. A. Benson for stimulating discussion.

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Cardiac Output and Central Pressure Data

Because of the importance of cardiac output and its relation to an individual's physical condition, it would be valuable to have a reliable relationship between the cardiac output of an animal or human being and his central pressure cycle at any moment and condition of interest. The only available formula of that type that is essentially scientific is one for stroke volume, due to Frank[1], namely,

$$V_s = At_s(\Delta p)/2c \qquad (1)$$

in which V_s is the stroke volume (cm.^{3}), A is the central patent cross-section (cm.^{2}), t_s is the duration of systole (sec.), Δp is the pulse pressure (dynes/cm.^{2}), and c is the propagation velocity of the pulse wave (cm./sec.).

It is possible to derive a slightly modified equation with more adaptability, starting with Frank's treatment of the pulse wave[2]. The basic equations are, first, a form of the Navier–Stokes equation for a viscous liquid:

$$\frac{\partial p}{\partial x} = -\rho\left(\frac{\partial v}{\partial t} + v\frac{\partial v}{\partial x}\right) - \frac{F}{A} \qquad (2)$$

in which x is distance from the source of pressure, t is time, ρ is the density of the liquid, v is the velocity averaged over the cross-section, and F is the viscous drag force per unit length of vessel; and secondly, a form of the continuity equation for the conservation of liquid in a section of tube of practically constant length:

$$\frac{\partial(Av)}{\partial x} = -\frac{\partial A}{\partial t} \quad \text{or} \quad A\frac{\partial v}{\partial x} = -\left(\frac{\partial A}{\partial t} + v\frac{\partial A}{\partial x}\right) \qquad (3)$$

The viscous drag force F decreases with increasing radius in either laminar or turbulent flow and is therefore found to be a negligible factor in the aortic flow of man or any large-sized animal. Since the last terms in the parentheses of equations (2) and (3) are approximately v/c times the respective first terms, and since the quantity $\frac{\partial A}{\partial p}\Big/A$ is practically constant, say k_p, it follows that equations (2) and (3) imply pressure and velocity waves travelling with a propagation velocity given approximately by:

$$c^2 = \frac{1}{\rho k_0}\left(1 - \frac{v}{c}\right)^2 \qquad (4)$$

If we assume that equations (2) and (3) imply a wave travelling outward (and thus parallel to the direction of $s = (t + x/c)/\sqrt{2}$ in the x–t plane), or that pulse pressure (Δp) includes no reflected or retrograde component (which would be in the $r = (t - x/c)/\sqrt{2}$ direction in the $x - t$ plane) it follows that when the aortic valve is efficient:

$$v_{max} = (\Delta p)\sqrt{k_0/\rho}$$

is an approximately correct relation. Since v/c is small compared to unity, this equation and equation (4) imply the Frank equation if the mean systolic velocity is $\rho/2$ times the maximum velocity—and independently of the *windkessel* model assumed by Frank[1].

To express the Frank relation in terms of cardiac output, and to introduce an arbitrary constant that can allow for species and other variation in the quantities and assumptions involved, we write the modified Frank equation in the form

$$Q = k_1 A(\Delta p)t_s/\rho cT = k_2(\Delta p)t_s/T \qquad (5)$$

in which Q is cardiac output (cm.³/sec.), k_1 is an arbitrary constant approximately equal to the mean-to-maximum systolic velocity ratio, T is the duration of one pulse, and $k_2 = k_1 A/\rho c$.

This modified Frank equation is readily tested by comparing its results with those obtained directly in dye dilution studies. Sufficient results for pressure and dye dilution for this purpose were reported by Warner, Swan, Connolly, Tompkins, and Wood[3] and by Kroeker and Wood[4]. The data for the resting state can be used to evaluate the k_2 of equation (5) and this can then be used to obtain the cardiac outputs predicted by equation (5) for the exercise and tilt conditions. When these outputs are obtained and compared with the dye results for seven normal and three abnormal humans (ref. 3) and for the average of twelve normal humans (ref. 4) the values given in Table 1 are obtained.

Table 1

Case, with ref. No. in brackets	$(k_2)_{rest}$	$Q_{exer.}$		Q_{tilt}	
		Dye	Equation (5)	Dye	Equation (5)
Normal					
1 (3)	0·0107	267	363	109	172
2 (3)	0·0059	238	194	93	79
3 (3)	0·0070	335	316	117	102
4 (3)	0·0100	277	266	93	111
5 (3)	0·0066	216	214	85	98
6 (3)	0·0069	—	—	86	82
7 (3)	0·0065	298	241	—	—
Aver. of 7 (3)	0·0077	272	266	97	107
Aver. of 12 (4)	0·0063	208	213	92	95
Mitral stenosis					
11 (3)	0·0066	175	170	—	—
12 (3)	0·0058	129	116	—	—
Pulmonary stenosis					
13 (3)	0·0051	—	—	79	88

These results show clearly the occasional inaccuracy and the broad range of approximate applicability of the modified Frank formula for estimating cardiac output from central pressure data. Its derivation also shows the assumptions on which it is based, which might have to be modified for extension to certain pathological conditions such as aortic insufficiency.

I wish to thank Drs. D. E. Donald, K. F. Hosie, H. J. C. Swan and M. B. Visscher for many helpful discussions, and the Rockefeller Foundation for a grant in support of this work.

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Influence of Salt Deficiency on Taste Sensitivity in Human Subjects

It appears to be well established that definite changes in preference and aversion behaviour can be elicited as a result of certain physiological changes in the animal[1–3]; for example, the effects of salt deprivation, adrenalectomy, lack of food and insulin injections on the preference–aversion behaviour of rats for salt and sucrose solutions respectively. That taste stimulation is an important determinant of this behaviour has been demonstrated by Pfaffmann[4], who found impairment in preference-aversion behaviour following bilateral removal of the chorda tympani and IXth nerves in rats. Richter[5], Hartridge[6] and Young[7] have suggested that certain physiological needs result in a change in taste sensitivity for the needed substance and that the changes in taste sensitivity are peripheral in nature. However, on the basis of electrophysiological work Pfaffmann and Bare[7] report "that salt deficiency does not alter the sensitivity of the taste receptors", and Pfaffmann and Hagstrom[8] conclude "that the enhanced sugar preference shown in behaviour studies following the injection of insulin is not associated with a change in taste sensitivity". Since these conclusions are based on records of afferent nerve impulses in the chorda tympani nerve the possibility of changes of a central origin in taste sensitivity are not excluded. In fact, Pfaffmann[9] has recently suggested that the behavioural changes referred to above "reflect not a change in the peripheral afferent neural message but changes in its significance for central neural processes".

In an endeavour to establish whether such changes in the significance of the afferent neural message are related to changes in taste sensitivity I have twice rendered a man and a woman deficient in salt, and studied their sensitivity to solutions in distilled water of sodium chloride, sucrose, sulphuric acid and quinine sulphate (chemicals supplied by B.D.H., Ltd.).

The psychophysical method of limits, ascending series only, was used to establish absolute thresholds. The series of concentrations (grams of solute per 100 cm.³ of solution) of the salt, sweet and sour solutions were graded in steps of 0·05 of a logarithmic unit, the bitter solutions in steps of 0·1 of a logarithmic unit. The subject rinsed his mouth with distilled water, 'dried' it by gently pressing the tongue against the roof of the mouth and swallowing excess moisture. He then sipped from a 1½-oz. glass 10 cm.³ of the taste solution, held it in his mouth for 5 sec. and expectorated, after which he rinsed again with distilled water and reported whether the solution tasted, say, 'salt' or 'not salt'. Solutions were presented at the rate of one per minute until two successive reports of salt were obtained. A rest pause of 2–4 min. was allowed between each of the

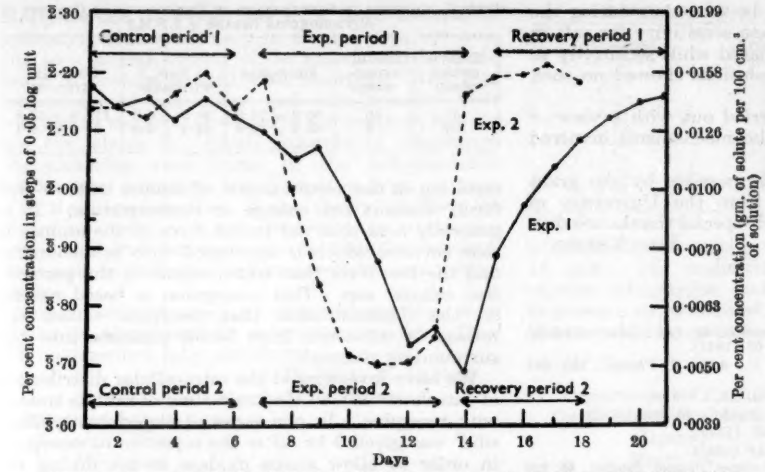

Fig. 1. Mean absolute thresholds for salt during experiments 1 and 2. Each threshold is the mean of eight determinations, four from each of two subjects

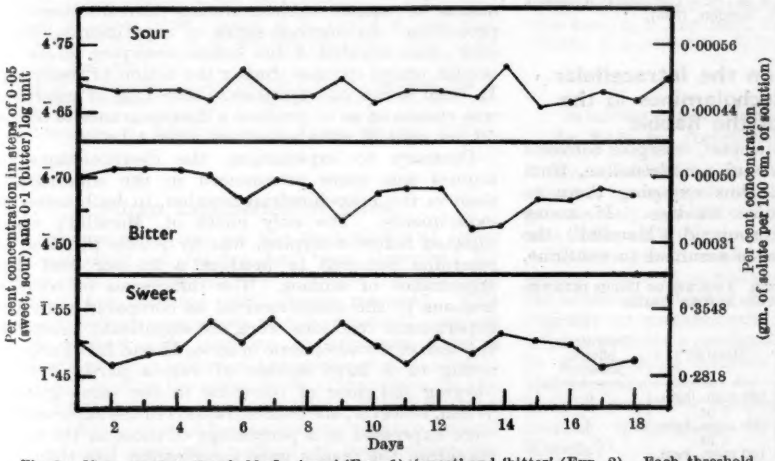
Sour
Bitter
Sweet
Per cent concentration in steps of 0·05 (sweet, sour) and 0·1 (bitter) log unit
Per cent concentration (gm. of solute per 100 cm.³ of solution)
Days

Fig. 2. Mean absolute thresholds for 'sour' (Exp. 1), 'sweet' and 'bitter' (Exp. 2). Each threshold is the mean of eight determinations, four from each of two subjects

four series tested in any one session. Threshold determinations for any one taste quality were always carried out at the same time of day. Before each experiment subjects were given considerable practice until they yielded reliable results.

Throughout the control, experimental and recovery periods (21 days for the first experiment and 18 days for the second) the overall caloric value of the food intake for both subjects was controlled. It averaged about 2,650 cal./day for the man (*R*) and about 2,100 cal./day for the woman (*H*). Water was allowed *ad libitum*. (All food was weighed ; nutritional values and sodium and chloride contents were calculated from ref. 9.) The salt intake from all sources for both subjects during the control periods of six days during both experiments was approximately 10 gm./day. During the experimental periods, of eight and seven days respectively, salt intake from all sources was reduced to an average of 80 mgm. sodium and 103 mgm. chloride/day and 75 mgm. sodium and 88 mgm. chloride/day for subject *R* and 78 mgm. sodium and 102 mgm. chloride/day and 72 mgm. sodium and 85 mgm. chloride/day for subject *H* in the first and second experiments respectively. This reduced salt intake was coupled with five 1½-hr. sweating sessions (in a hot room at 95° F. wet bulb, 105° F. dry bulb) during the first experiment and four 2-hr. sweating sessions during the second experiment. Losses in body-weight of 1·750 kgm. and 2·100 kgm. for subject *R* and 1·800 kgm. and 1·550 kgm. for subject *H* were recorded over the first and second experimental periods respectively. The results of analysis of venous blood samples for serum-sodium and plasma-chloride concentrations, taken during the second experiment, are shown in Table 1. Silver nitrate tests at the end of each experimental period showed the urine of both subjects to be practically clear of chloride. It appears reasonably certain then that in both cases the subjects were in a mild state of salt deficiency during the latter stages of the experimental periods.

Salt intake for both subjects during the first recovery period of seven days was restricted to approximately 7½ gm./day for the first four days of recovery and during the second recovery period of five days was increased to 22 gm./day for the first two days of this period, to 18 gm. for the third day, whereafter normal salt intake was resumed. This difference in salt intakes during the initial stages of the recovery periods appeared to influence the return of the salt thresholds to control-period levels, as shown in Fig. 1, where the mean salt thresholds for both subjects throughout the two experiments are presented. Fig. 2 presents the mean absolute thresholds of both subjects for 'sour' in the first experiment and for sucrose and 'bitter' during the second experiment.

Table 1. Serum-Sodium and Plasma-Chloride taken during Experiment 2*

Day of experiment	Serum-sodium (m.equiv./l.)		Plasma-chloride (m.equiv./l.)	
	Subject *R*	Subject *H*	Subject *R*	Subject *H*
6	140	143	108	109
9	138	135	104	106
11	136	134	102	103
13	138	133	101	105
14	140	141	109	111
16	142	144	109	110

* Thanks are due to Prof. R. A. McCance, Department of Experimental Medicine, University of Cambridge, for arranging the taking and analysis of these samples.

From these results it can be seen that during the periods of salt deficiency taste sensitivity for salt in both subjects definitely increased while sensitivity to 'sweet', 'sour' and 'bitter' solutions showed no such changes.

Further work is being carried out with a view of gaining some insight into the mechanisms involved in this phenomenon.

This investigation is made possible by the grant of a Hackett studentship from the University of Western Australia, for which special thanks are due.

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Effect of Reserpine on the Intracellular Distribution of Catecholamines in the Brain Stem of the Rabbit

According to current concepts[1], reserpine converts amines, such as serotonin and noradrenaline, from 'bound' into 'free' forms, thus exposing them to rapid destruction by amine oxidase. If amine oxidase is inhibited by iproniazid ('Marsilid') the releasing effect of reserpine is assumed to continue, resulting in the accumulation of amines in their free form, without net change in concentration. It is generally held that the bound form of the amines is that fraction which is associated with mitochondria and the free form that which occurs in the particle-free cellular sap. This conception is based mainly on the demonstration that reserpine causes the release of serotonin from blood platelets into the surrounding plasma[2].

We have investigated the intracellular distribution of catecholamines in the brain stem of rabbits treated with reserpine. In one series of experiments, 'Marsilid' was given 3 hr. after the injection of reserpine, in order to allow amine oxidase to act during the action of reserpine. The administration of 'Marsilid' in these experiments was intended to prevent the action of amine oxidase during the fractionation procedure. In another series of experiments, 'Marsilid' was injected 2 hr. before reserpine so as to inhibit amine oxidase during the action of reserpine. In both series of experiments the dose of reserpine was chosen so as to produce a disappearance of about 50 per cent of catecholamines after 4 hr.

Contrary to expectation, the disappearance of amines was more pronounced in the supernatant than in the mitochondrial fraction, in both series of experiments. The only effect of 'Marsilid', when injected before reserpine, was to double the dose of reserpine required to produce a 50 per cent disappearance of amines. The differences of concentrations in the mitochondrial as compared with the supernatant fractions were not significant except in the case of noradrenaline in series II and III (Table 2), owing to a large scatter of values partly due to varying the dose of reserpine in the same groups. When, however, the concentrations in the supernatant were expressed as a percentage of those in the mitochondria, the means were significantly less than 100 in all cases except for hydroxytyramine in series II (Table 3).

It has further been claimed that reserpine prevents the incorporation and retention of newly formed amines in bound form. The injection of dihydroxy-

Table 1. Schedule of Experiments. Amounts of Drugs injected and Time of Injection before Death

Experimental group	Reserpine*	'Marsilid'†	Dihydroxyphenylalanine*
I	0	100 mgm./kgm. 1 hr.	0
II	0·25–0·5 mgm./kgm. 4 hr.	100 mgm./kgm. 1 hr.	0
III	0·5–1·0 mgm./kgm. 4 hr.	100 mgm./kgm. 6 hr.	0
IV	0·5 mgm./kgm. 4 hr.	100 mgm./kgm. 6 hr.	60 mgm./kgm. 0·5 hr.
V	0·5 mgm./kgm. 4 hr.	100 mgm./kgm. 6 hr.	60 mgm./kgm. 5 hr.

* Intravenous. † Intraperitoneal.

Table 3. Content in Supernatant as Percentage of Content in Mitochondria (means ± S.E.M.)

Experimental group	No. of experiments	Adrenaline	Noradrenaline	Hydroxytyramine
II	10	63·2 ± 13·6	58·5 ± 8·0	110·8 ± 43·8
III	6	63·2 ± 5·8	64·1 ± 5·0	45·2 ± 9·1

Table 2. Effect of Reserpine on the Intracellular Distribution of Catecholamines in the Brain Stem of the Rabbit (means ± S.E.M.

Experimental group	No. of experiments	Fraction	Adrenaline	Noradrenaline	Hydroxytyramine	Dihydroxyphenylalanine
			(μgm./kgm. wet weight)			
I	8	Total	82·3 ± 9·2	311·5 ± 38·4	417·6 ± 90·0	0
		Coarse	11·1 ± 1·0	47·2 ± 7·3	59·9 ± 11·8	0
		Mitochondria	31·0 ± 4·0	119·3 ± 16·5	148·1 ± 36·9	0
		Supernatant	28·7 ± 3·3	106·9 ± 12·2	157·0 ± 52·0	0
II	10	Total	38·2 ± 8·3	223·3 ± 49·6	141·7 ± 48·3	0
		Coarse	5·5 ± 1·6	28·8 ± 7·2	24·9 ± 7·3	0
		Mitochondria	18·3 ± 3·5	114·5 ± 25·6	68·8 ± 20·5	0
		Supernatant	10·8 ± 2·9	57·2 ± 9·9	60·8 ± 19·2	0
III	6	Total	37·4 ± 6·4	169·0 ± 18·1	186·1 ± 78·4	0
		Coarse	7·0 ± 1·2	30·6 ± 6·5	35·9 ± 18·7	0
		Mitochondria	17·3 ± 3·6	72·4 ± 9·3	98·3 ± 37·4	0
		Supernatant	10·1 ± 1·5	45·7 ± 5·5	46·9 ± 19·8	0
IV	3	Total	90·8	230·0	4,347	19
		Coarse	17·4	40·8	779	1·0
		Mitochondria	33·1	78·8	1,761	19·1
		Supernatant	39·2	105·2	2,370	4·7
V	1	Total	57·5	306	4,020	0
		Coarse	lost	—	—	—
		Mitochondria	22·4	141	1,620	0
		Supernatant	20·2	84	1,520	0

phenylalanine, however, led to a large increase of hydroxytyramine not only in the cell sap, but also, and to a similar extent, in the mitochrondria in the brain of rabbits treated with reserpine. The concentrations of adrenaline and noradrenaline were restored to the level observed in the controls, but did not rise above it. Small amounts of dihydroxyphenylalanine were found in the mitochrondria 0·5 hr. after injection, but none after 5 hr.

It thus appears that, if the theory of reserpine action is correct, it is not permissible to equate the bound and free forms of amines with the fractions contained in mitochondria and cellular sap respectively.

The techniques used in this investigation were similar to those used in a previous study[3]. They will be described fully elsewhere.

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Micro Estimation of Urea

A qualitative test for the recognition of urine contamination of fabrics has been described by Ishler *et al.*[1]. With the aid of urease the ammonia evolved was detected with Feigl's reagent[2]. This reagent (silver manganese nitrate solution) appears to be rather more sensitive to ammonia than is Nessler's reagent (alkaline potassium–mercuri-iodide solution), having its lower limit of detection in the order of 0·5 μgm. ammonia. Using Feigl's reagent and a filter paper spot test technique we have devised a rapid and economic method of determining the concentration of urea in 5–20 μl. of biological fluid.

Approximately 20 μl. fresh blood, cerebrospinal fluid, diluted urine, etc., are accurately pipetted into a small (50 mm. × 8 mm.) citrated tube to which is added one drop of 10 per cent w/v soya bean meal suspension (prepared in 0·1 per cent citrate and buffered with sodium hydroxide so that the *p*H falls within the range 6·8–7·2). A washed filter paper (Whatman No. 3 *MM*) is then clamped over the open end of the tube and moistened with 1 drop of Feigl's reagent. At the end of 6 min. incubation in an oven at 120° C. the intensity of the manganese dioxide/free silver deposit is compared with those obtained by similarly treated standard urea solutions. Under these conditions the urease suspension is capable of converting 30 μgm. urea quantitatively to ammonia within 1 min. (Table 1). No ammonia has been detected as a result of heating either human blood or urease suspension alone for 10 min. at 130° C.

Blood analyses are frequently performed in all hospital biochemistry laboratories in order to assess the extent of urea retention. In view of this, and the fact that the classical methods of Van Slyke and Cullen[3] and Archer and Robb[4] require about an hour to complete 12 estimations, a simple apparatus has been designed which deals successfully with 24 analyses in less than 15 min. In pædiatric units our method has obvious advantages, and furthermore, may be used to screen a larger number of patients for hyperuræmia than would otherwise be possible.

Table 1. Recovery of Urea added to Blood

Urea added (mgm./ml.)	Urea found (mgm./ml.)	Urea recovered (mgm./ml.)
0·0	0·15	—
0·3	0·35	0·2
0·51	0·6	0·45
0·78	0·9	0·75
1·26	1·4	1·25
1·72	1·7	1·55
2·1₀	2·2	2·05
2·46	2·8	2·65

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Audiogenic Epileptic Seizures evoked in Rats by Artificial Epileptogenic Foci

We consider the so-called audiogenic epilepsy in rats to be epileptic seizures of the procursive or procursively convulsive type which can be produced as a reflex to a strong acoustic stimulus.

Hitherto, seizures of audiogenic epilepsy have been evoked either in initially sensitive animals or in rats the sensitivity of which had been increased pharmacologically or metabolically. In our experiments we tried to produce a predisposition to audiogenic seizures in non-sensitive animals by creating an artificial epileptogenic focus by the local application of alumina-cream—a method introduced into experimental epileptology by Kopeloff, Barrera and Kopeloff[1].

Experiments were performed on rats, approximately two months old, the sensitivity of which to acoustic epileptogenic stimuli was determined by repeated testing. Six tests, consisting of a powerful electric bell sounding for two minutes in a cylindrical, 50 cm. × 50 cm., sound-proof box, were given in the course of two weeks. A thin gel of aluminium hydroxide was applied by micro-injection, with the aid of the stereotaxic apparatus, into three different regions of the brain. Rats were then observed and tested weekly for 5–12 months.

2–6 mm.³ of the cream were injected subdurally or intracortically into one or both motor areas (area 4) or into the acoustic area (area 41 according to Krieg[2]) either uni- or bi-laterally in 75 rats. Audiogenic seizures after a latent period of 2–77 days were observed in 25 rats (33 per cent). The dependence of this artificial audiogenic epilepsy on the position of the focus is evident from Fig. 1. Foci in the optic zone (area 17) in control experiments, and in the cerebellar cortex, did not evoke audiogenic seizures.

In 35 rats, 1–3 mm.³ of alumina-cream was injected into the inferior collicule of the lamina quadrigemina. Audiogenic seizures were observed in 34 per cent of animals after a latent period of 9–219 days. Seizures

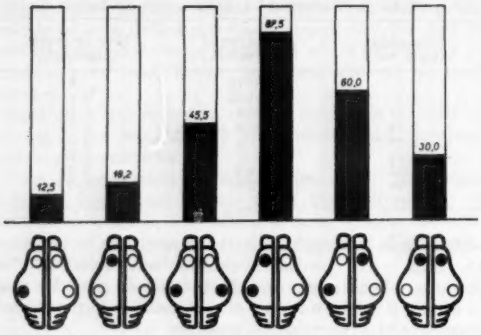

Fig. 1. Audiogenic epilepsy evoked in rats after application of alumina-cream to the cerebral cortex. Top, percentage of audiogenic epileptic siezures; bottom, diagram of position of application of alumina-cream

appeared more frequently after a very long latency period. In one rat spontaneous seizures were observed without the acoustic stimulus.

The histological findings corresponded to changes usually observed after the application of alumina-cream.

In most rats 1–2 electroencephalographic examinations were performed during intervals between the seizures. These were carried out under chloral-hydrate or dial narcosis, using monopolar or bipolar leads from needle epidural or intracortical electrodes. In most cases spike potential activity was observed over the hemisphere with the artificial focus in animals with cortical lesions. The corticogram of rats with a lesion in the inferior collicule was usually normal; it was only in a few cases that focal spike activity or spike and wave activity was also found. This was mostly localized in the motor area, though it was not possible to determine a constant relationship between the localization (lateralization) of the subcortical focus and the topographical distribution of electroencephalographic changes.

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Mutagenic Action of Actinophages

We have already described some results of work on mutations in *Actinomyces olivaceus* strain *N*-6 due to the action of actinophage No. 1 [1].

Further investigations have shown that actinophages differ from one another not only in virulence but also in mutational spectrum. The results on mutation frequency in *Actinomyces olivaceus* strain *N*-6 due to two more actinophages (No. 2671 and No. 8238) are presented in Table 1.

Two facts observed by us are of particular interest. The first concerns the effect of the donor on the mutagenic properties of the actinophage. Phage No. 1 was grown on two species of Actinomycetes. The first variant of phage No. 1 was grown on *Streptomyces griseus* strain No. 2 (or *Act. globisporus streptomycini* according to Krasilnikov's classification). The second variant of phage No. 1 was grown on *Act. olivaceus* strain *N*-6. Strain No. 2 of *Str. griseus* produces white yellowish colonies, and strain *N*-6 of *Act. olivaceus* produces dark grey colonies. Thus, two variants of actinophage No. 1 had been obtained. These two variants of actinophage No. 1 were used for infecting cultures of strain *N*-6 of *Act. olivaceus*. The mutants induced by the two variants of actinophage No. 1 appeared to be quite different (Table 2).

Table 1

Mutation types	Percentage mutation produced by Phage No. 1	Phage No. 2671	Phage No. 8238
Dark grey, typical	1·54	2·74	27·9
Light grey	20·0	0·58	absent
White	2·3	3·0	5·9
Non-sporulating	0·64	0·23	absent
Mosaic	1·25	absent	19·0
Brown	absent	0·35	absent
Bright yellow, folded, asporogenic	absent	49·3	absent
Black	absent	absent	6·9
Light grey, folded, asporogenic	absent	absent	40·3
Dwarf	35·5	43·8	absent
Light yellow, poorly sporulating	34·2	absent	absent
Lemon-yellow, film-like	4·5	absent	absent
Light green	0·07	absent	absent

The mutants induced by the second variant of actinophage No. 1, grown on strain *N*-6 of *Act. olivaceus*, reflected some features of the donor. There were black and dark brown mutants among them, the number of white mutants being small. Light yellow, light grey or lemon-yellow mutants were not present at all. The mutants induced by the first variant of actinophage No. 1 grown on strain No. 2 of *Str. griseus* also reflected some features of the donor. Black and dark brown mutants were not observed among them, whereas light grey, light yellow or lemon yellow mutants were rather abundant.

This qualitative peculiarity was observed from experiment to experiment, thus presenting a basis for the assumption that actinophage not only changes the genotype of the infected culture, by inducing mutations in it, but also appears to be a carrier of the donor genetic information affecting the mutagenic properties of the actinophage.

The second point of interest concerns the following phenomenon. 504 colonies from the plates of the phagolysate of *Act. olivaceus* strain *N*-6 infected with actinophage No. 1 grown on strain *N*-6 of *Act. olivaceus* were transferred to agar tube slants. The tests of these colonies for biochemical deficiency revealed 16 biochemical mutants among them (or 3·17 per cent). All the biochemical mutants were

Table 2

Mutation types	Percentage mutation produced by: First variant of phage No. 1	Second variant of phage No. 1	Controls (without phage added)
Dark grey, typical	1·7	1·17	96·3
Light grey	10·5	absent	0·9
White	3·5	0·23	2·0
Light yellow	44·3	absent	absent
Mosaic	0·3	0·94	0·2
Non-sporulating	0·6	0·94	0·6
Lemon-yellow	2·6	absent	absent
Light green	0·3	0·23	absent
Black	absent	18·0	absent
Brown	absent	15·0	absent
Dwarf	36·2	63·5	absent

stable and retained their properties on passages. Of the 16 biochemical mutants, 11 required amino-acids. Examination of 504 colonies from the control plates of the same strain, that is, from the plates without phage, revealed no biochemical mutants.

This confirms our assumption that actinophage is a mutagenic factor; but whether this mutagenic action is based on transduction, and, if so, how the emergence of the auxotroph under the action of actinophage grown on a prototrophic strain can be explained, are as yet unknown.

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Chaining and Unchaining *Streptococcus faecalis*—a Hypothesis of the Mechanism of Bacterial Cell Separation

It was observed that in young broth cultures, *Streptococcus faecalis* (enterococcus) grows in marked chains which later break up rather abruptly; the chains can be maintained by spinning young cultures and resuspending the cells in fresh medium. It was further found that many unrelated compounds are capable to a greater or lesser degree of inducing chain formation in enterococci, the most active being detergents, suramin and crystal and gentian violet; bile[1] was moderately active. In the presence of these compounds enterococci grow rough, with a clear supernatant and a heavy granular deposit consisting of long, tangled chains. On transfer to ordinary media the organisms revert to the typical, smooth, diffuse type of growth with little sediment—singles, pairs and short chains predominating.

It was assumed, as working hypothesis, that the final stage of cell division, that is, cell separation, is due to an enzyme system, its deficiency or inactivity leading to the formation of larger or smaller aggregates. Indeed, Webb[2] has already shown that chains of *Clostridium welchii* can be broken up by an enzyme obtained by disintegrating cells of this species. In the light of the present hypothesis compounds inducing chain formation would do so by inhibiting either the synthesis or the activity (or both) of the cell-separating system.

Direct proof of the idea came from experiments in which chains were broken up by supernatants of short-form cultures. Horse heat-infusion broth with 1 per cent 'Oxoid' peptone was used throughout. Supernatants of 18–24 hr.-old cultures of five strains of enterococci served as source of the cell-separating system, autoclaved supernatants as controls. Chains were obtained by growing the same strains in the presence of detergents or, more commonly, suramin (0·5–1 per cent) afterwards removed by washing with saline; alternatively, an atypical strain of enterococcus growing naturally in long chains (N.C.T.C. 2400) was used. The tubes containing mixtures of chains and supernatants were placed in the water-bath at 37° C. and the length of chains in experimental and control tubes compared at intervals by examining wet and Gram-stained preparations. In the experimental tubes 'induced chains' became visibly shorter after a few minutes and broke up within 15 min. to 3 hr.; in the control tubes the chains persisted for 6–24 hr., but eventually broke up. Chains of strain N.C.T.C. 2400 were slower to break up and, as expected, persisted in the controls. The cell-separating system was found to be considerably impaired by heating for 30 min. at 70° C. and completely destroyed by boiling for 5 min.; it is largely retained by Seitz filters, partly by sintered glass filters; its activity appears greatest around *p*H 7. It acts on cells killed by boiling; here the chains become very rapidly Gram-negative prior to unchaining.

During the unchaining of live cells, lysis invariably occurred, though its degree varied with the strain used as source of the unchaining system. Lysis showed first as single Gram-negative cells within Gram-positive chains, their numbers increasing with time. At later stages the outline of such cells becomes indistinct and it is assumed that they eventually disintegrate. The possibility that Gram-positive cells remained connected by Gram non-staining material was considered: it was ruled out by the results of examination of wet preparations in which short chains, pairs and singles showed independent drifting and Brownian movement. That the cell-separating system is identical with or part of a lytic system is a distinct possibility; on the other hand, lysis may be incidental or even a consequence of unchaining. Preliminary results seem to indicate the existence of a similar cell-separating system in Gram-positive and Gram-negative rods; a full account of the results will be published elsewhere.

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Spontaneous Occurrence of Intranuclear Inclusion Bodies in Continuous Cultures of Renal Cells

This communication describes the spontaneous occurrence of intranuclear inclusion bodies of *A* type[1] in renal cells of the dog which have been propagated in continuous tissue cultures. Spontaneous occurrence of the intranuclear inclusion bodies in normal tissue cultures has, to the best of my knowledge, never been reported. The primary tissue cultures were prepared by a modification of a trypsin digestion technique[2]. The cells were grown on histological coverslips (2 in. × ½ in.) inside 1-oz. screw-capped bottles, which were incubated in a horizontal position at 37° C. Each bottle contained 3 ml. of a nutrient medium (*p*H 7·0–7·2) composed of 1·0 per cent lactalbumin hydrolysate and 20 per cent chicken serum in Hanks's balanced salt solution. Phenol red (0·002 per cent), penicillin (100 u./ml.) and streptomycin (100 μgm./ml.) were added to the medium. When cell sheets were established (5–6 days), the cells were dispersed with 0·5 per cent versene and re-suspended in a fresh portion of the medium, using the method of Jordan[3], to give the desired count.

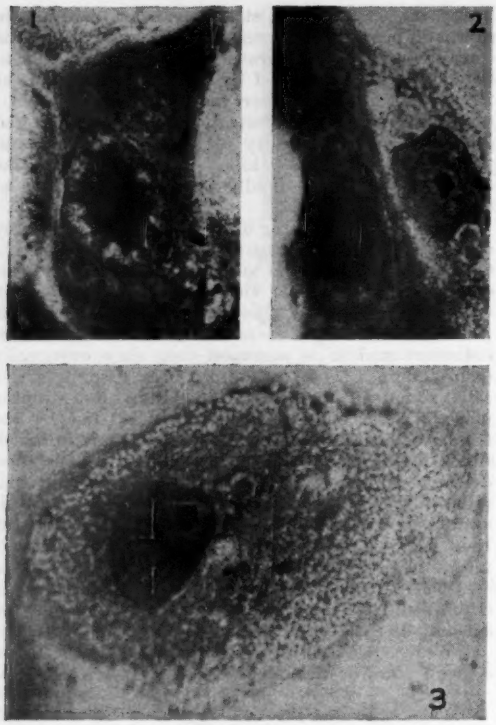

Fig. 1. 1, A mature intranuclear inclusion (× 500); 2, a nucleus with a mature inclusion and a normal nucleus (× 500); 3, one large epithelial cell showing fine dark lines crossing the nuclear substance, vacuolization of the cytoplasm and the beginning of the separation of endoplasm and ectoplasm (× 500)

Morphological studies were first made of unstained cultures; these were stained with giemsa by a modification of Buckley's method[4].

The inclusions were first detected in unstained cells of the first and second subcultures, and hence they were not artefacts of staining. The first change in the nucleus seemed to consist of a small aggregate of chromatin. This gradually increased in size until it occupied a major portion of the nucleus. The mature inclusions (Fig. 1) were either round, oval or irregular in contour, generally corresponding to the shape of the nucleus. There was also margination of the chromatin towards the nuclear membrane, which remained intact and was separated from the inclusion by a clear zone.

In addition, many nuclei lost their round smooth contour, showing shrinkage and indentation; some became pyknotic and irregular in shape. A few nuclei showed several shorter or longer dark lines apparently crossing the nucleus (Fig. 1). These might have been the first stage of wrinkling of the nucleus. Similar lines have been described in tissue cultures of human amniotic cells inoculated with poliomyelitis virus[5]. Tissue cultures with the intranuclear inclusions also showed vacuolization and foaming of the cytoplasm. In some cells there was a sharp separation of ectoplasm from endoplasm.

Since the tissue cultures originated in a dog with a history of virus hepatitis, it was tempting to regard the inclusions as a specific response of the cells to latent hepatitis virus[6,7]. On the other hand, the occurrence of inclusion bodies in organ sections from cases where no virus can be demonstrated, is regarded by some authors as an obscure reaction by the host cells to some physical or chemical stimulus[8]. There is, however, increasing recognition that many virus infections of animals, plants, and bacteria have no overt symptoms or signs, and also that latent virus can be activated by the most varied physical or chemical stimuli[9]. Therefore, in many cases, confusion arises as to the true nature of inclusion bodies. However, the evidence in this communication shows that intranuclear inclusion bodies can occur spontaneously in tissue cultures, and should this phenomenon occur in virus-inoculated cultures it may be wrongly attributed to activities of the virus inoculum.

I am indebted to Mr. W. G. Orbell for technical assistance. The stimulating discussions of the problem of inclusion bodies with Prof. C. Jackson are acknowledged with pleasure.

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Resistance of Protein–Lignin Complexes, Lignins and Humic Acids to Microbial Attack

The mechanism whereby organic matter, especially the protein moieties, is protected from rapid and complete break-down in soils is not fully understood. The interaction of clay minerals and organic materials with a resultant attenuation in breakdown of these substrates has been reported by a number of workers[1]. These proposed clay–organic complexes have much to commend them, but they fail to account for a core of resistant organic matter also found in soils which are low in clay minerals. This core of organic matter appears to be either a mixture or a chemical union of lignin-like materials and proteins.

Several workers[2] have prepared synthetic protein–lignin complexes simulating soil humic acid. While the reports are somewhat conflicting, in general, these complexes were attacked and degraded by the soil microflora with some difficulty.

A number of protein–lignin complexes were prepared from *H*-lignin and several proteins including casein, egg-albumen and two soybean proteins. About 10 gm. of *H*-lignin and 2 gm. of the protein in question were dissolved in dilute sodium hydroxide and the *p*H lowered by the addition of 0·5 *N* hydrochloric acid in complexes *A* and *B*, with 2 *N* hydrochloric acid for complex *C* and with 0·5 *N* orthophosphoric acid in the case of *D* and *E*. In *E* a ratio of 10 : 4 *H*-lignin to soybean protein was used.

The precipitated protein–lignin mixtures were shaken for 48 hr. and then were dialysed for 24 hr.

Table 1. THE CARBON DIOXIDE EVOLVED FROM THE BREAKDOWN OF 100 MGM. OF LIGNIN–PROTEIN COMPLEXES, LIGNIN–PROTEIN MIXTURES, LIGNIN AND HUMIC ACID AND THEIR RELATIVE NITROGEN CONTENT

	Complex m.equiv.	Average m.equiv.	Time (days)	Mixture m.equiv.	Average m.equiv.	Nitrogen (per cent)
			Casein–lignin			
	1·70			3·33		
(*A*)	1·81	1·82	27	3·20	3·33	4·48
	1·96			3·46		
			Egg albumen–lignin			
	1·34			2·13		
(*B*)	1·56	1·51	28	1·79	2·10	3·0
	1·62			2·38		
			Soybean protein–lignins			
	2·13			2·02		
(*C*)	2·01	2·15	27	2·13	2·15	2·4
	2·31			2·29		
	1·41			2·11		
(*D*)	1·51	1·46	21	2·06	2·09	3·8
	2·55			3·47		
(*E*)	3·13	2·87	21	3·86	3·73	6·44
	2·93			3·87		
			Humic acid (*) and lignin (†)			
	0·98*			1·30†		
(*F*)	0·71*	0·84*	28*	1·40†	1·33†	
	0·83*			1·29†		

against tap-water. The remaining material was dried in a large evaporating dish at 40° C. The dry material was ground and the nitrogen content determined (Table 1) by the macro-Kjeldahl method. From this figure the amount of protein in the complex was ascertained and an equivalent amount was added to prepare the *H*-lignin–protein mixtures.

The *H*-lignin was prepared by washing a sulphite-extracted lignin with dilute acid followed by aqueous ethanol. The humic acid was obtained from a Pocomoke sandy loam by extracting the organic matter with 0·5 *N* sodium hydroxide and precipitating the humic acid with hydrochloric acid. The humic acid was dialysed against tap-water, dried and finely ground. The *H*-lignin and humic acid had nitrogen contents of 0·14 and 2·5 per cent respectively.

100 mgm. of the substrate to be tested was suspended in a mineral medium containing inorganic nitrogen and a phosphate buffer (*p*H 6·6) and inoculated with a soil suspension. Air free from carbon dioxide was bubbled through the medium and the carbon dioxide evolved from the break-down of the substrates was collected in baryta solution.

In most cases, except for *C*, the complexes evolved less carbon dioxide than did the equivalent mixtures. The highest degree of resistance to break-down was shown by the lignin–casein complex, where 43 per cent more carbon dioxide was evolved by an equivalent lignin–protein mixture. The soybean protein–lignin *C* prepared by precipitation with 2 *N* hydrochloric acid showed no protection from break-down; presumably the conditions of preparation were too drastic. The egg-albumin and the two soybean protein–lignin mixtures (*B*, *D* and *E*) evolved 28, 25 and 23 per cent more carbon dioxide respectively than did the complexes. It appears that a certain ratio of protein to lignin allows the greatest resistance to break-down. This may be because the number of stable reaction sites between the lignin and protein are limited.

The lignin and humic acid were very resistant to microbial attack. The humic acid, despite its nitrogen content of 2·5 per cent, was attacked the least in liquid medium. A portion of this nitrogen was present as protein nitrogen as determined by paper chromatography of the hydrolysate.

It is apparent from these results that some interaction of protein and lignin occurs which results in an attenuation of microbial break-down over a period of weeks. This attenuation is not so marked as in the case of soil humic acids. Infra-red spectra of these complexes proved unfruitful in determining the nature of the protein–lignin interactions.

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Action of Deoxyribonuclease on Lampbrush Chromosomes

UNTIL a few years ago it was generally assumed that nucleic acids lack the diversity required of primary genetic material, and proteins alone were supposed to possess this attribute. The results of early studies of enzymic digestion of chromosomes[1] appeared to support this concept, for although nucleases and pepsin were found to be unable to break chromosomes, trypsin effected complete disintegration. Darlington's theory[2] of the nucleic acid 'charging' of chromosomes is based on the supposition that the linear integrity and genetic specificity of chromosomes is maintained by a backbone of protein, to which deoxyribonucleic acid becomes 'attached' at certain stages in mitotic and meiotic cycles. If such deoxyribonucleic acid acquires specificity, this is derived through association with chromosome protein.

In recent years ideas have changed and nucleic acid rather than protein has been favoured as the primary genetic material: in bacteria and phages there is strong evidence that genetic continuity resides in deoxyribonucleic acid, and by analogy it is widely assumed that this holds for higher organisms[3]. In keeping with the newer ideas, the conclusions drawn by earlier workers from observations of the disruptive action of trypsin on chromosomes have recently been challenged. Kaufmann[4,5] has shown that the disintegration of salivary-gland chromosomes of *Drosophila* which have been fixed in 45 per cent acetic acid and subjected to tryptic digestion is due to the unrestrained hydration of persisting deoxyribonucleic acid components of the chromosomes: this occurs only in the presence of certain electrolytes, not when digestion proceeds under salt-free conditions, and is not an effect of trypsin *per se*. Moreover, Gall[6] has shown that trypsin does not destroy the axes of unfixed lampbrush chromosomes from oocytes of *Triturus*: the earlier observations to the contrary were made on fixed and sectioned material. The evidence that the linear integrity of chromosomes depends on the strength of a continuous protein chain, or even of discontinuous protein linking chromomeres together, is therefore no longer cogent. However, there has been, as yet, no conclusive demonstration that chromosomes possess a continuous deoxyribonucleic acid skeleton, and indeed Kaufmann came to the conclusion that no single substance or class of substances could be identified as solely responsible for the linear integrity of chromosomes;

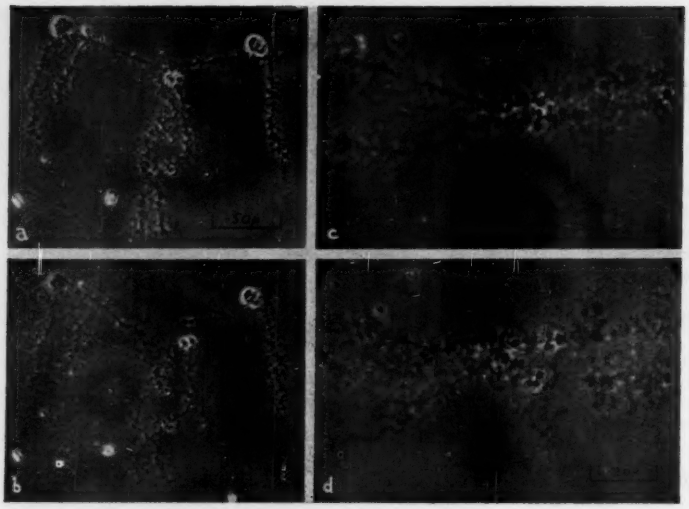

Fig. 1. Phase-contrast photographs of lampbrush chromosomes of *Triturus cristatus carnifex* taken with a xenon flash to 'stop' Brownian movement: (*a*) Bivalent X entire before enzyme attack; (*b*) same bivalent after 4 min. of deoxyribonuclease action; (*c*) middle region of Bivalent VII before enzyme attack; (*d*) same region after 4 min. of deoxyribonuclease action. Axial breaks and fragmented lateral loops visible in photographs (*b*) and (*d*)

rather "the chromosome represents a complex fabric in which ribose and desoxyribosenucleic acids are intimately associated with each other and with histones and nonhistone proteins" (ref. 5, p. 422). Working with lampbrush chromosomes from oocytes of the newt, *Triturus cristatus*, and with the enzymes pepsin and trypsin (Armour) and ribonuclease and deoxyribonuclease (Nutritional Biochemicals) we have reached a different conclusion.

The only parts of fixed lampbrush chromosomes which stain Feulgen-positive are chromomeres lying in the axes of the chromosomes. Chromomeres are connected to one another by a very thin fibril[7], which when free from casually adherent material cannot be resolved in the light microscope. There is conclusive evidence for the presence of a submicroscopic axis running within the resolvable matrices of the lateral loops[8], and circumstantial evidence that these loop axes are drawn out from the Feulgen-positive chromomeres.

Lampbrush chromosomes were isolated without fixation into a physiological saline in which they may be preserved for many days, and were examined in specially constructed cells by means of an inverted phase-contrast microscope (as originally proposed by Gall[6]) while active enzyme preparations were applied. The enzymes were made up in salines having the same molarity as the medium used for isolating the chromosomes (approximately 0·07 *M*) pepsin at *p*H 2·7, trypsin at *p*H 6·2, ribonuclease at *p*H 6·3 and deoxyribonuclease at *p*H 6·3. The salines containing trypsin, ribonuclease and deoxyribonuclease were lightly buffered with phosphate. Pepsin was used at an effective concentration of 0·125 mgm./cm.^{3}, trypsin at 0·125 mgm./cm.^{3}, ribonuclease at 0·1 mgm./cm.^{3} and deoxyribonuclease at 0·015 mgm./cm.^{3}. Adequate controls were run with comparable salines lacking enzyme and at the appropriate *p*H values.

Pepsin, trypsin and ribonuclease all bring about the solution of loop matrix materials, together with certain other structures attached laterally to the axes of the chromosomes, but these enzymes do not destroy the linear integrity of the chromosomes. The action of deoxyribonuclease, however, is dramatically different. The submicroscopic fibrils connecting adjacent chromomeres snap, and the lateral loops fragment into smaller and smaller pieces (Fig. 1), each piece however conserving, for a time at least, the fine-scale morphological peculiarities of the loop from which it originated. A drastic disruption of the chromosomes is already visible within a few minutes of the beginning of enzyme treatment, and in half an hour Brownian movement has so scattered the fragments that no recognizable trace of the original forms of the chromosomes remains. In our experience no other chemical agent has been found capable of breaking lampbrush chromosomes in this fashion, and the conclusion is inescapable that deoxyribonucleic acid runs throughout the lengths of lampbrush chromosomes, including the axes of their lateral loops. We cannot, of course, say that protein is not associated with the deoxyribonucleic acid throughout its length, but if this should be so it can scarcely be an extended fibrous protein endowed with independent structural integrity: by far the greater mass of lateral loop material consists of ribonucleoprotein, yet this fails to keep the loops intact once their axes have been destroyed.

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Formation of Jerusalem Artichoke Tubers in Sterile Culture

During the development of shoots of *Helianthus tuberosus* L. in sterile *in vitro* culture, swollen, ellipsoidal structures bearing scale leaves, and producing roots, were formed. These structures resemble, and are considered to be, tubers. The shoot cultures were derived originally from the growth of sterilized 'eyes' of tubers (artichoke strain *P* 17 of Nitsch and

Nitsch[1]). From a leafy shoot growing in sterile culture, a section of stem 1 cm. long, including a single node with its pair of foliage leaves, was taken as explant, and was placed on a complex medium containing salts, 2 per cent sucrose, naphthaleneacetic acid (0·01 mgm./l.), casein hydrolysate, and coconut milk. The composition of the medium is given by Marsden and Wetmore[2], except that cysteine and urea were omitted. When kept at 25° C. in a 12-hr. day at the relatively low light intensity afforded by pairs of fluorescent lamps and tungsten lamps at a distance of about 1 m., one or both axillary buds of the explant grew out into elongated shoots bearing foliage leaves (referred to hereafter as long shoots). Tubers were first noticed forming sporadically in such cultures, either at the base, or in the axils at recently formed nodes, or at the shoot apex. Fig. 1*A* shows a culture of the latter type, in which roots are forming abundantly from the tuber even though it is wholly in the air. The tubers would continue to grow if the entire culture, or the portion bearing the tuber, were transferred to new medium at intervals of about a month, and they could attain lengths of several centimetres; some, however, 'bolted' after transfer, that is, the apex grew out as a long shoot.

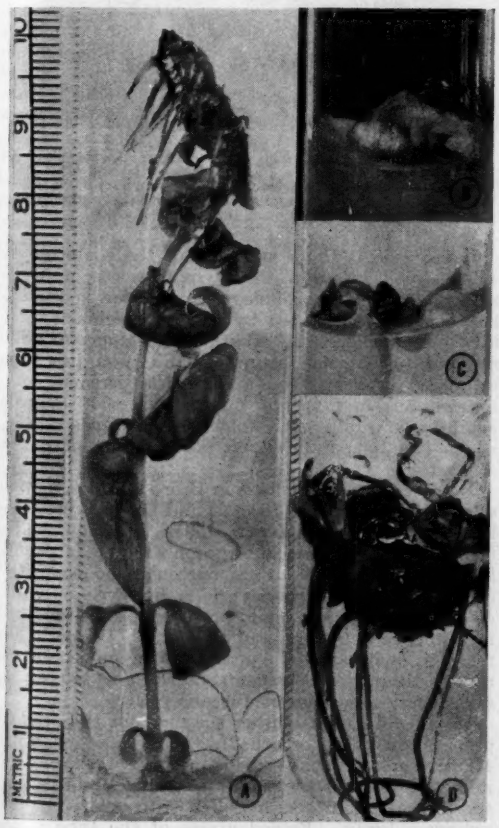

Fig. 1. Tubers formed in cultures of *Helianthus tuberosus*. *A*, tuber formed apically upon a shoot which had developed under low light intensity, 25° C.; four months old. *B*, tuber formed in one axil of explant, in the dark at 25° C.; four weeks old. *C*, tuber in axil of explant, formed in continuous high-intensity illumination at 16–17° C.; four weeks old. *D*, tuber ten weeks old which had been formed in the axil of the explant as in *C*, and transferred to new medium after four weeks; the arrow marks the position of the apex

Tubers would form also from explants maintained at 25° C. in total darkness. In the dark they remained completely white in colour, whereas the tubers which formed in the light were green and became coloured to varying degrees with anthocyanin. Tubers which formed in the dark always developed directly from the axillary buds of the explants (see Fig. 1*B*).

When cultures were grown in light of higher intensity (in a temperature-controlled light room about 1 m. beneath banks of fluorescent lamps and tungsten floodlamps), buds in one or both of the axils of the explant grew out vigorously into long shoots, and no tubers were formed, either in short (8-hr.) or long (16-hr.) day (day temperature 24–25° C., night temperature 19–20° C). (By inserting small sterile thermometers inside the tubes containing the cultures, it was found that the temperature of the air within the tubes under the lights was some 4° C. higher than that of the surrounding air. Temperatures mentioned are those found within the culture tubes.) However, in cultures under the same light intensity but at a day temperature of 16–17° C. (night temperature 13° C.), no long shoots developed at all, and most of the explants produced intensely purple-coloured tubers in the axils of the original leaves, even under continuous illumination. An example of such a culture in a relatively early stage of development is shown in Fig. 1*C*. These tubers continued to increase in size and number of nodes for months, and almost never bolted; an older and unusually large one is shown in Fig. 1*D*.

Series of cultures were grown under short day in various combinations of day temperatures of 24–25° and 16–18° C., with night temperatures of 25°, 19° and 13° C. In day temperature 24–25° C., vigorous long shoots, and no tubers, developed with night temperatures of 25° or 19° C., but with night temperature 13° C. about a third of the cultures had formed small tubers within a month (often in addition to a long shoot), and among the cultures in this treatment the length and vigour of the long shoots which formed varied greatly, some being similar to those at higher night temperature, while others had small leaves and very short internodes. In day temperature 16–18° C., tubers and no long shoots formed with night temperature 13° C.; whereas with night temperature 19° C., about half the cultures formed tubers, many of which soon bolted, and all the aerial shoots which developed had conspicuously shortened, and often swollen, internodes coloured purple with anthocyanin; they suggested an incompletely expressed tendency towards tuber formation.

In looking for an effect of day-length on tuber formation it was felt important, consequently, to try to eliminate temperature differences between treatments. A day-length effect was sought at 18–19° C. day and night temperature, where, since some but not all of the cultures form tubers, an effect of day-length might be expected to be pronounced. However, no conspicuous difference in the proportion of cultures forming tubers was observed between 8-hr. and 16-hr. day. It would appear that if there is a day-length effect, it is much less conspicuous than that of temperature under the culture conditions. In none of the treatments were any differences noticed between the behaviour of explants derived from cultures grown at 25° C. under long as opposed to short day.

The observations may be summarized by saying that tuber formation in cultures of nodal pieces of *Helianthus tuberosus* was promoted by decreasing the temperature or the light intensity; this conclusion resembles that suggested by Mes and Menge[3] for cultures of *Solanum tuberosum*. The detailed results, as well as the morphology of the tubers and of interesting transitional types which have appeared, will be presented later.

I am grateful for the interest and advice of Profs. R. H. Wetmore and K. V. Thimann, and for the partial support of this work under grant *G*-182 from the U.S. National Science Foundation. Part of the work was performed while I held an American Cancer Society postdoctoral fellowship.

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Palynology of the Brora Coal of the Scottish Middle Jurassic

New preparations have been made from new samples taken at the coal face in the Brora mine in 1955 (with the kind permission and assistance of the manager). These came from various levels in the coal, above it (in the mine), and below it in the shore exposure, but they showed no trace of the angiosperm pollen attributed to the Nymphaeaceae by Simpson[1]. We have also re-examined the original slides which were very generously sent to us by Dr. Simpson.

The specimen of Simpson's Fig. 2*a* labelled *Nelumbium* type has been re-examined and is interpreted as *Zonalapollenites* close to *Z. dampieri* Balme[2], which species has recently been described (1957) from Western Australia. Several closely allied forms have been recorded (N. F. H.) from the British Jurassic and Lower Cretaceous, including one in which the body is only slightly different in sculpture from the bladder. The narrow equatorial bladder of *Zonalapollenites* is sometimes (particularly in *Z. trilobatus* Balme) divided into three sections; Simpson's Fig. 2*a* shows such division, but the specimen illustrated is crushed at one side. There is often a vestigial trilete scar or ridge which is also seen in Simpson's figure, but there are no colpi or furrows. The size of approximately 70μ (Fig. 2*a*) is in agreement with the general range of *Zonalapollenites* (55–75μ).

Fig. 2*d* of Simpson (specimen re-examined) is interpreted as a folded specimen of *Araucariacites australis* Cookson with which it agrees in size (70μ) and which is common in the Brora samples; the so-called furrows are quite irregular in outline. Fig. 2*c* labelled *Castalia* type, shows a grain of the same size as that in Fig. 2*d* and is almost certainly a folded specimen again of *Araucariacites australis*; an alternative is *Inaperturopollenites* Thomson and Pflug (species figured by Balme). There are in the Brora samples many grains of *Classopollis torosus* (Reissinger) which do show a circular furrow and operculum; these are, however, always much smaller, being invariably less than 45μ, and they have been shown to belong to such gymnosperms as *Pagiophyllum connivens*. The other Figs. (2*b*, *c*, *f*) were not of Mesozoic specimens.

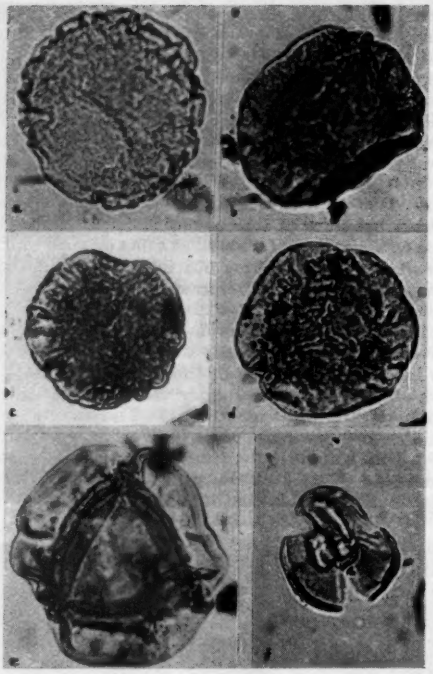

Fig. 1. (*a*) *Zonalapollenites* sp., Brora coal; (*b*) *Zonalapollenites* sp., folded as in Simpson's Fig. 2, Wealden; (*c*) and (*d*) *Z.* cf. *dampieri* Balme, showing trilete mark, Wealden; (*e*) *Z.* cf. *trilobatus* Balme, Upper Wealden; (*f*) *Eucommiidites troedssoni* (Erdtman), polar view, Brora Coal. (× 500)

In no case is there any sign of the sculpture or exine stratification of the Nymphaeaceae, and the suggested furrow morphology of these few specimens has not been supported by further specimens from these preparations. In addition, the *Magnolia* grain referred to but not figured by Simpson has been examined (indicated on a slide in a personal communication) and is not monosulcate; it appears again to be a differently folded *Araucariacites* grain, which can be paralleled on pollen slides of recent *Araucaria*.

Present in great numbers in Brora samples, as well as in those from other Jurassic and Lower Cretaceous localities, is *Eucommiidites troedssoni* Erdtman[3]. This form does not appear in Simpson's figures, although his description of grains as "opercular monocolpate" could apply to this species; it is, however, only 30–40μ in diameter and could not therefore be involved in Simpson's figures and account. Couper[4] has recently demonstrated its probable gymnospermous nature, although it clearly remains the most interesting and uncertain species of Jurassic pollen.

In general aspect neither the new nor the original preparations differ markedly from those of other Middle Jurassic rocks of Scotland or Yorkshire. The microflora of all these contains normal Mesozoic fern spores and gymnosperm pollen with relatively few unknown forms. Folded grains of the type under discussion can be seen in many other preparations.

We therefore conclude that no water-lily or other angiospermous pollen grains have yet been found in this locality and that all the records are referable to gymnospermous pollen; use of these records in any argument should be at least suspended until support-

ing evidence is produced. We wish to emphasize that all the species mentioned above were described long after Simpson's publication and that we only feel that it is necessary to record this correction because of the frequent uncritical references of other authors to the Brora Coal. It may still be proved that there were pre-Cretaceous angiosperms, but this particular evidence must be discarded.

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Occurrence of Collagen in the Phylum Mollusca

CONSIDERABLE interest has recently been shown in the occurrence of a collagen type of protein among the various invertebrate groups. X-ray diffraction[1,2] studies have explored a wide range of examples, and more recently chemical investigations have used various chromatographic techniques to determine the composition of certain preparations[3–5]. Most of this work has been performed on tissues from single species bearing little or no relationship to one another. In the present study, the occurrence of collagen has been investigated in representatives of the three major classes of the phylum Mollusca, using the occurrence of hydroxyproline as an indication of the presence of a collagen-type protein. The examples were: class Gastropoda, *Helix aspersa* (garden snail); class Lamellibranchiata, *Mytilus edulis* (edible mussel); class Cephalopoda, *Loligo vulgaris* (common squid).

The dead animals were washed in isotonic saline for several days, rinsed with distilled water and blotted dry with filter paper Moisture content, which was close to 85 per cent for all the samples, was estimated by drying to constant weight at 105° C. and the ash was measured by igniting at 550°. Hydroxyproline was determined by a modification[6] of the Neuman and Logan[7] procedure and total nitrogen by Kjeldahl determination. Results have been expressed in terms of the ratio of hydroxyproline nitrogen to total nitrogen. Analyses were performed on the whole snail and mussel and on the parts of the animals indicated in Table 1. Determinations on the squid were carried out on various regions and not on the whole animal. The byssus apparatus and ctenidia were dried *in vacuo* over phosphorous pentoxide before analysis was carried out. The results in Table 1 show the presence of hydroxyproline and hence of collagen in almost all samples examined, with a tendency to be concentrated into specific structures. This is particularly shown for the snail, where the collagen is concentrated in the body-wall.

About 240 gm. of mussel bodies were extracted with hot water at *p*H 4·5 using higher temperatures for each successive extract (60–90° C.). The material containing hydroxyproline went preferentially into solution, the mean hydroxyproline nitrogen to total nitrogen ratio (as per cent) being 0·76 for the extracts.

Table 1. OCCURRENCE OF HYDROXYPROLINE IN THREE SPECIES OF MOLLUSCA

Species	Sample	Ash (percentage in dry material)	Percentage in dry, ash-free material		Hydroxyproline nitrogen/total nitrogen (per cent)
			Hydroxyproline	Total nitrogen	
Helix aspersa	Whole animal	13	0·94	7·75	1·30
	Body-wall		1·91	9·5	2·16
	Viscera		Trace		
Mytilus edulis	Whole animal	8	0·48	10·3	0·49
	Byssus apparatus		1·50	8·4	1·9
	Ctenidia		0·60	8·0	0·80
Loligo vulgaris	Mantel wall	23	0·43	16·1	0·29
	Fin	11	1·06	11·5	1·00
	Cranial cartilage	12	4·15	9·3	4·80
	Head–foot*	15	0·82	12·5	0·70

* One arm together with associated part of head

Approximately 50 gm. of snail bodies (dry weight about 8 gm.) were soaked for a short time in 5 per cent hydrochloric acid, followed by numerous changes of ½ per cent sodium chloride both before and after removal of the viscera, for a week. Preliminary experiments had shown that a short treatment of the snail body-wall with saturated lime water increased the rate of extraction of hydroxyproline-rich material in warm water. Four changes of lime water were given during four days. The body-wall material was washed and extracted at 70° C., 2 hr., 80° C., 2 hr. and 90° C., 2 hr. The first extraction was lost in an unsuccessful attempt to fractionate it. The second and third extracts were filtered and concentrated and dried over phosphorus pentoxide. The second extract was observed to set to a gel at 4° C. after concentration. The analytical results for these extracts are given in Table 2.

Table 2. ANALYSIS OF EXTRACTS FROM LIMED SNAIL BODY-WALLS

Extract	Yield (mgm.)	Ash (per cent)	Percentage in dry, ash-free material		Hydroxyproline nitrogen/total nitrogen (per cent)
			Hydroxyproline	Total nitrogen	
2	112	4·0	10·8	16·6	6·95
3	200	3·6	12·6	17·8	7·6

It was noted that the hydrolysate of both extracts was light in colour and resembled that for gelatin samples known to be largely free of polysaccharide. The hydroxyproline and total nitrogen figures are therefore likely to be close to those of the intact collagen of the snail body-wall.

I am indebted to Dr. A. Courts and Mr. A. A. Leach for valuable discussion.

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Comparative Biological Effectiveness of the Gibberellins

Since the isolation[1] of gibberellin A (later identified[2] as a mixture of gibberellins A_1, A_2 and A_3), and more recently the discovery[3] of gibberellin A_4, numerous physiological responses have been induced in plants[4] with the gibberellins. Takahashi *et al.*[3] reported that A_1, A_2 and A_3 all possessed strong physiological activities in stimulating the elongation of rice seedlings. Apart from this reference, the gibberellins have not been evaluated in terms of specific biological activities. The comparative effectiveness of gibberellins A_1, A_2, A_3 and A_4 and the methyl esters of A_1 and A_3 in promoting vegetative extension, flowering of facultative long-day annuals and in fruit setting is now reported[5].

Beans (*Phaseolus vulgaris*, var. Blue Lake) were germinated in quartz sand, transferred to solution cultures, and after 24 hr. 10 μl. of a 3×10^{-3} M solution of a gibberellin or derivative was applied to the stem apex. Epicotyl elongation was determined after 48 hr. Gibberellins A_1, A_2 and A_3, applied to the stem apex, resulted in significantly greater epicotyl extension than the methyl esters of A_1 and A_3 (Table 1). No significant differences were apparent among the gibberellins. All produced significantly longer epicotyls than the controls. By contrast, in unpublished studies (with B. K. Gaur), gibberellins A_1 and A_3 applied to one of the primary leaves of the bean produced significantly longer epicotyls than A_2. This has suggested a limitation in absorption-transport of gibberellin A_2.

Table 1. Comparative Biological Activity of Gibberellins and Methyl Ester Derivatives

Compound	Epicotyl extension in the bean (percentage of control)	Flowering in lettuce		Stimulation of parthenocarpy in tomatoes (percentage of non-pollinated control)
		Seedstalk heights (cm.)	Time to visible flower primordia (days)	
Control	100	40·5	164·9	296*
3-Indoleacetic acid	—	—	—	216
para-Chlorophenoxyacetic acid	—	—	—	320
Gibberellin A_1	260	49·8	145·3	208
Methyl ester of gibberellin A_1	147	36·4	157·7	160
Gibberellin A_2	253	36·1	157·3	204
Gibberellin A_3	267	54·8	139·3	228
Methyl ester of gibberellin A_3	127	38·8	154·1	140
Least differences necessary for significance at 5 per cent	32	7·9	6·7	47
1 per cent	42	10·4	8·8	64

* Pollinated control.

The effects of the gibberellins and derivatives on flowering were determined with lettuce (*Lactuca sativa*, var. Great Lakes) and dill (*Anethum graveolens*) grown in pot cultures and treated initially at the 6–7 leaf stage with 10 μl. of the solution described above. Treatments were repeated after two and four weeks. All plants were grown at a night temperature of 18° C. and at the prevailing winter photoperiod (9–11 hr.). The time required for flower primordia to appear in lettuce was significantly reduced and seedstalk heights were increased by treatment with gibberellins A_1 and A_3. Plants treated with A_2 or the methyl esters of A_1 and A_3 flowered slightly earlier than controls, but seedstalk elongation was not affected. Furthermore, no heads formed on plants following treatment with A_1 or A_2, whereas bolting followed heading on plants treated with A_3, the methyl esters of A_1 and A_3, and the controls. Similar effects on acceleration of flowering and seedstalk heights were observed with dill.

Comparative fruit-setting activities, in the absence of pollination, were determined with the tomato (*Lycopersicon esculentum*, var. Michigan–Ohio Hybrid). Three flower buds from the first cluster were emasculated approximately 24 hr. before anthesis. 10 μl. of a 3×10^{-3} M solution of the gibberellins, methyl esters of A_1 and A_3, indoleacetic acid or *para*-chlorophenoxyacetic acid were then applied to the ovary, and its diameter measured after six days. Solutions of gibberellins A_1, A_2 and A_3 and indoleacetic acid were equally effective in stimulating growth of ovaries, but less so than *p*-chlorophenoxyacetic acid at 3×10^{-3} M concentration. At a lower concentration (3×10^{-5} M), however, A_1, A_2 and A_3 were as effective as *p*-chlorophenoxyacetic acid and more so than indoleacetic acid. As in other responses the methyl esters of A_1 and A_3 were less active than their free acids.

Preliminary studies have indicated that gibberellin A_4 was equal in activity to A_1 for promotion of epicotyl extension of the bean and parthenocarpy in tomatoes. It was, however, less effective in stimulating stem elongation and flowering in lettuce and dill.

A consideration of the comparative biological activities of the gibberellins relative to epicotyl extension in beans, stem elongation and flowering in lettuce and dill, and parthenocarpic fruit growth in tomatoes has established the following order of activity: $A_3 > A_1 \simeq A_4 > A_2 >$ methyl ester $A_1 \simeq$ methyl ester A_3.

We thank Dr. Y. Sumiki, University of Tokyo, for gibberellins A_1, A_2 and A_4 and Dr. J. F. Grove, Imperial Chemical Industries, Ltd., for A_3 and the methyl esters. These studies were supported in part by grants from Chas. Pfizer and Co., Inc., and Merck and Co., Inc.

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Effects of Alkoxyglycerols and especially Selachyl Alcohol on the Bone Marrow in connexion with Irradiation Treatment and in Leukæmia Therapy

In connexion with irradiation treatment it has been shown that alkoxyglycerols to a certain extent prevent and cure leuko- and thrombo-cytopænia[1]. It was found that the effect was related to the amount of alkoxyglycerols administered *per os*. Above a certain dosage there is less effect.

The alkoxyglycerols occur in the form of esters or free alcohols in bone marrow and other potentially blood-forming tissues. In our first experiments we used preparations from cattle bone marrow. For later work we utilized Greenland shark-liver oil, which may contain as much as 50 per cent of alkoxyglycerol esters[2].

For a comparative study of the effect of the natural oil and of the purified product, as well as of the esters alone and of the different alkoxyglycerols, it was necessary to develop a sensitive and rapid animal test. We used rats according to the method of Lindell and Zajicek[3].

The effect on rats 6 days after they had received a total-body X-irradiation of 250 r. was studied. Megakaryocytes and nucleated cells were counted in the femoral bone marrow. At this time the megakaryocytes reach their lowest value, while the nucleated cells, which reach a minimum only 2 days after the treatment, are approaching normal values again. The various preparations were given intraperitoneally and daily, for 4–10 days before irradiation and then continuously until the day the rats were killed. Comparison with control rats, which received X-ray treatment at the same time, but which were given the solvent only (intraperitoneally : 5 per cent 'Tween 80' in physiological saline), showed that the prophylactically-treated group had a higher count of both megakaryocytes and nucleated cells than the control group. As in humans, the effect was found to be related to the quantity administered and it decreased above an optimal dosage.

Table 1 gives the megakaryocyte counts from a series of experiments using natural shark-liver oil (50 per cent active agent), a purified concentrate of esters (95 per cent active agent), and some free alkoxyglycerols.

Table 1. MEGAKARYOCYTE COUNT (M) (IN PER CENT OF THE MEGAKARYOCYTES FOR NORMAL RATS)

	No. of rats	(mgm./day)	M (per cent)	
Normal group	70		100	$M = 50{\cdot}000$
Control group	87		19	
Prophylactic group :				
Shark liver oil	18	0·25	26	
Shark liver oil	9	0·40	33	
Shark liver oil	23	0·50	27	
Pure esters	3	0·25	29	
Batyl alcohol	11	0·14	32	
Selachyl alcohol	8	0·12	61	
Selachyl alcohol	6	0·14	49	
Selachyl alcohol	12	0·18	27	

The marked effect of selachyl alcohol on the bone marrow, far greater than that of any other constituent of the shark-liver oil, stimulated the resumption of earlier experiments on alkoxyglycerols in leukæmia therapy. The alkoxyglycerols have been tried in about thirty cases of acute children's leukæmia, where we have sometimes had positive results, both clinically and hæmatologically. The best response is in cases of leuko- and thrombo-cytopænia. Sometimes the alkoxyglycerols only are administered, and sometimes, especially when there is no response in 10–14 days, cortisone is administered as well. However, this is only for very short periods of 7–10 days, with later repetitions if necessary. Apparently alkoxyglycerols can usefully be administered at the same time as antagonists of purines or of folic acid. It also seems that the alkoxyglycerols may be of value in cases where leuko- or thrombo-cytopænia has already occurred, due to previous treatment.

When testing the alkoxyglycerols in leukæmia therapy we have experienced difficulties with dosage, due perhaps to the optimal-dose effect. The preparations were administered *per os*. Usually we used an emulsion of purified Greenland shark-liver oil, which contains about 50 per cent of alkoxyglycerol esters, in daily doses 0·15 gm. per kgm. body-weight. The dose was divided in three or four portions to be taken with meals. If there is a favourable effect, the dosage is gradually decreased to a minimum maintenance quantity after 2–3 weeks (generally a quarter of the original dose). A possible over-dosage is generally shown by a temporary retardation of the favourable effect. If the preparation is then stopped for a short period this symptom usually disappears in 2–5 days.

Clinical experiments with selachyl alcohol have been started. Great care is needed when using this substance, which seems to be very active. At present we are trying an initial dose of 10 mgm. per kgm. body-weight per day.

A more detailed account of this work will be given elsewhere.

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Nature of the Antigens responsible for the Acquired Tolerance of Turkeys to Rous Sarcoma Agent

THE original observations of Simonsen and Harris[1,2] that tolerance in turkeys to Rous sarcoma agent could be produced by inoculating turkey embryos or one-day-old poults intravenously with normal whole blood from the strain of fowls in which the tumour was propagated, has been confirmed by Svoboda and Hasek[3]. It soon became apparent[4] that living cells were not required for the transmission of this tolerance. This was of great interest, because Billingham, Brent and Medawar[5] found that the capacity of whole blood to confer tolerance to tissue transplantation resides entirely in the leucocyte fraction, the antigens responsible apparently being those of the cell nucleus. Antigens of spleen cell nuclei have been shown to confer transplantation immunity when injected into immunologically mature animals[6], but transplantation tolerance has, as yet, only been conferred upon embryos and immunologically immature animals in the presence of intact donor cells. The two questions to which we addressed ourselves were, therefore: (1) Was this tolerance of the tissue transplantation or of the serum antibody type? (2) Was a single antigen involved and, if so, what was it and what was its relationship to the antigens of the Rous agent?

The acquired-tolerance antigens were present only in the cellular fraction of whole fowl blood and they withstood freeze-drying without impairment[4]. Moreover, they were not completely destroyed by heat (49° C., 20 min.) that was sufficient to abolish their tolerance-conferring property, both for skin homografts and, in the case of turkeys and chickens, for skin heterografts[7].

The acquired-tolerance antigens have also been found to be non-specific. Blood from a different strain of fowls was fully competent and turkey poults given pigeon blood (and a pigeon skin graft) on the day of hatching promptly destroyed the graft, but retained a high sensitivity to the sarcoma virus. Similarly, guinea pig blood cells, formolized sheep erythrocytes and human group A (Rh+) cells conferred tolerance, but rat and human group O (Rh+) cells were incompetent.

These data, summarized in Table 1, gave support to the idea[4] that Forssman-type antigens should be investigated. These have been postulated as components of fowl sarcoma virus[6] and have also been shown to be closely associated with fowl myeloblastosis virus[9].

Table 1. Production of Tolerance to Rous Agent in Turkeys given Intravenous Inoculation of Blood Cells

Antigens* (intravenous)	No. of poults	No. of tumours	Percentage
Control	63	7	11
Brown Leghorn, washed blood cells	45	30	67
Brown Leghorn, freeze-dried whole blood	14	7	50
Light Sussex × Rhode Island Red, washed blood cells	9	8	88
Sheep, formolized blood cells	26	9	35
Human, group A (Rh+) washed blood cells	19	14	74
Human, group O (Rh+) washed blood cells	14	1	7

* 1 ml. or its equivalent of whole blood was given intravenously on the first day after hatching. 42–50 days later the turkeys were given intramuscular injections into each leg of cell-free agent equivalent to 50 mgm. whole tumour.

Turkey tolerance to Rous agent was conferred by carefully prepared ghosts from chicken red blood cells and also by soluble cell-free extracts prepared from blood cells by the method of Kirby[10]. This extract, which had to be administered by intraperitoneal inoculation, gave a tolerance comparable with that obtained by the use of whole washed chicken blood cells given to one-day-old turkeys by the same route (Table 2).

Fractionation of this extract, which contained deoxypentosenucleic and pentosenucleic acids, proteins and a polysaccharide has shown that the tolerance-conferring antigen is a polysaccharide. This polysaccharide is non-dialysable, contains fucose and inhibits, at very low concentrations, the agglutination of human group A cells by specific antiserum.

Experiments with purified blood-group A substance from hog gastric mucin are in progress, and we conclude that the antigen responsible for conferring tolerance in turkeys to Rous sarcoma agent is very similar to, or identical with, blood group A substance.

Attempts to identify this material in purified Rous agent itself have thus far been inconclusive. This may merely be a matter of preparing enough of the purified agent and in this connexion it is probably significant that blood group A substances have been shown to have Forssman-like activity.

Table 2. Production of Tolerance to Rous Agent in Turkeys given Intraperitoneal Inoculation of Chicken Blood Cell Extract

Antigens* (intraperitoneal)	No. of poults	No. of tumours	Percentage
Control	63	7	11
Brown Leghorn, washed blood cells	23	10	43
Cell extract (*E*)	62	28	45
E, deoxyribonuclease-treated	33	13	39
E, ribonuclease-treated	12	6	50
E, treated with both nucleases	12	10	83
E, treated with trypsin and chymotrypsin	13	7	54

* The equivalent of 1 ml. whole blood was given by the intraperitoneal route on the first day after hatching. 42–50 days later the turkeys were given intramuscular injections into each leg of cell-free Rous agent equivalent to 50 mgm. whole tumour.

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Dried Organic Substances as Food for Larval Annelids

Many workers have found the provision of suitable food materials for rearing marine larvæ a major difficulty. Previously, the choice has been limited to marine unicells, of which only *Phaeodactylum tricornutum* has been widely used for rearing larval annelids. No quantitative feeding investigations have been carried out with annelids comparable to those of Bruce, Knight and Parke[1] and Davis[2] with oyster larvæ; and those of Raymont and Gross[3] and Marshall and Orr[4,5] with *Calanus finmarchicus*. The experimental work reported here was carried out to compare the food values of readily obtained dried organic substances and various unicells (Table 1) for larvæ of *Cirratulus cirratus*.

All feeding experiments were carried out in a constant-temperature room at 15° C. The larvæ selected were derived from both natural and artificial fertilizations. Feeding experiments were started at approximately 30 days after fertilization, when all yolk had disappeared from the gut and after the young worms had been washed by repeated changes of Berkefeld-filtered sea water to achieve oligoseptic conditions. The worms were selected in a manner designed to ensure similar groups and generally 10, but in some experiments 20, larvæ were placed in each experimental dish, which were either Boveri dishes (capacity 50 ml.) or beakers (capacity 100 ml.). All glassware was heat-sterilized prior to use and Berkefeld-filtered 'outside' sea water was used throughout. Glassware and water were changed every fourth day.

Table 1. MEAN GROWTH-RATES/MONTH (IN μ) OF LARVÆ GIVEN VARIOUS FOOD MATERIALS

Food	Total months tested	No. of experiments	Mean growth/month (μ)
Dried liver powder	57·7	9	1,047
Dried egg powder	10·5	2	531
Dried nettle powder	10·0	2	162*
Marine unicells:			
Chaetoceros decipiens	10·5	2	529
Phaeodactylum tricornutum	12·4	5	479
Dunaliella sp.	10·5	2	272
Skeletonema costatum	6·6	2	241
Coccolithus huxleyi	1·8	1	189
Chrysochromulina sp.	2·6	2	114*
Chlorella stigmatophora	3·8	1	0

* Growth in one experiment only.

In the case of the unicells, 20 drops of a flourishing culture were given every four days, while in the case of the dry organic materials 1·0 mgm. of the powder was given every four days. These amounts appeared by observation to be slightly in excess of the requirements of both larvæ and juveniles and were consistent with keeping them in a healthy condition. Larvæ and juveniles were measured in a state of maximum extension at fortnightly or monthly intervals. Mean growth-rates on all the foods given are shown in Table 1, while growth-rate figures for a typical experiment are shown in Fig. 1. Student's t test was applied to estimate the significance of the differences between means of the growth-rate results and a probability of 5 per cent was taken as the division between significance and non-significance.

Liver powder produced a mean growth-rate/month of 1,047μ and was significantly more effective in this respect than any of the other food materials tested. It was found that young worms could be maintained for more than two years on this substance. Of the unicells, *Chaetoceros* and *Phaeodactylum* gave the greatest growth-rates, but these were not significantly different from the growth produced by the second organic substance—egg powder (531 μ/month). Next in order of effectiveness were *Dunaliella* and *Skeletonema*, which again were not significantly different from each other. In one experiment there was slight growth in larvæ given *Coccolithus*, nettle powder and *Chrysochromulina*, though at a lower rate than with *Skeletonema* and *Dunaliella*. However, in a second experiment, larvæ given nettle powder and *Chrysochromulina* failed to grow. There was also no growth in larvæ fed on *Chlorella* or in control larvæ (unfed). The results demonstrate that larvæ of *Cirratulus cirratus* can be reared on a variety of food materials, both living organisms and dead organic matter. Liver powder, which was the most effective food tested, and egg powder, which gave results equivalent to the best of the unicells, have several advantages in rearing work. Exact amounts can be weighed and thus conditions standardized to a high degree, and, further, much less labour is involved than is the case in maintaining algal cultures. Some success in current experiments with larvæ of *Arenicola marina* (unpublished results), which are notoriously difficult to rear, suggests that liver powder may be generally useful for rearing annelids. However, initial work by Dr. S. M. Marshall on *Calanus* and by Dr. H. A. Cole and Dr. R. H. Millar on oyster larvæ, does not encourage the belief that it will have a wide applicability as food for small organisms belonging to other groups, though more extended work is necessary.

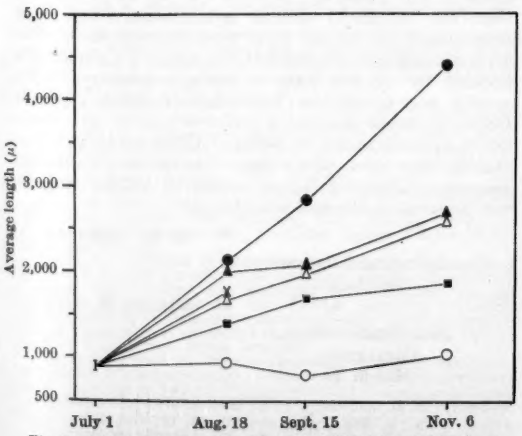

Fig. 1. The average growth of larvæ of *Cirratulus cirratus* in a typical experiment. Larvæ given liver powder, ●—●; egg powder, ▲—▲; *Phaeodactylum*, ×—×; *Chaetoceros*, △—△; *Dunaliella*, ■—■; starved controls, ○—○

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A Theory of Visual Thresholds

Gregory and Cane[1] have proposed a statistical information theory of visual thresholds which derives the empirical laws governing absolute and differential visual thresholds from certain plausible assumptions about the properties of the eye as a detector of visible radiation. An essentially similar theory was restated and elaborated by Cane[2] in a later paper.

The basic theoretical equation defining the threshold is:

$$\frac{[(r + \Delta r) - r] - C}{\sqrt{\left(\frac{1}{A_1} + \frac{1}{A_2}\right)V}} = \text{constant} \qquad (1)$$

where r, $r + \Delta r$ are the mean neural pulse-rates in the areas A_1 and A_2, illuminated by intensities I and $I + \Delta I$ respectively, V is the variance of neural pulse rates over the sample, and C is a constant sufficiently large to ensure only a small proportion of false positives.

This equation may be interpreted by saying that a positive response is given whenever the increment in pulse-rate exceeds C. The constant on the right, which I shall call β, depends on the statistical definition of threshold. The distribution of δr, the actual increment in pulse-rate, is not known, but if it is assumed that it is roughly normal, and if the areas are measured in suitable units, then β will take the values $+1$, 0 and -1 for definitions of threshold,

corresponding roughly to 80, 50 and 20 per cent positives.

Assuming that $r \propto \log(I + k)$, where k is a positive constant, possibly related to the noise background, the authors deduce the equation:

$$1 + \frac{\Delta I}{k} = \exp(C + \alpha\sqrt{1/A}) \qquad (2)$$

for the absolute threshold ΔI for an area A. In this equation the constant α is a positive multiple of β, the constant on the right of equation (1).

The authors proceed to derive Ricco's law for small fields and Piper's law for larger fields from equation (2). But their derivations involve implicitly the assumption that α is positive; this is true when the threshold is defined by 80 per cent positive responses, but for about 50 per cent positive responses α is zero, and for lower values it becomes negative.

Equation (2), in fact, implies that for some definition of threshold for which $\alpha = 0$ (about 50 per cent positive responses), ΔI, the absolute threshold in terms of illumination, is independent of area. The variations with area for other definitions of the threshold are due to the frequency of seeing curves plotted against ΔI for large areas being steeper than those for small. For 80 per cent positive responses ΔI increases as the area diminishes, as the authors conclude; but for 20 per cent positive responses, ΔI diminishes as the area diminishes, becoming negative for very small areas.

The fallacy lies in deriving an equation for the threshold applicable only to the particular areas A_1 and A_2 considered, and then varying the areas without considering which of the other quantities in the equation remain invariant under this treatment. In equation (1), C is defined for the areas A_1 and A_2; there is no reason for supposing that in equation (2) C will remain constant while A is varied. Further, the relationship $r \propto \log(I + k)$ is certainly not true for small areas if the area is varied. Hartline's[3,4] experiments showed that in the eye of the frog over a wide range of intensities and areas r depends on the total flux IA. The human retina is also composed of a mosaic of functional units, and there is every reason for believing that in the present respect these units behave like the functional units of the frog. Further, diffraction and optical defects may make the images of very small areas virtually identical. These facts provide the simple and generally accepted explanation of Ricco's law—and certainly a theory which seeks to explain the law without taking them into consideration must be regarded with the gravest suspicion.

The authors' assumptions thus do not lead to reasonable conclusions about visual thresholds, and considerable modifications to their theory are required before it can be regarded as a useful approach to the problems of visual excitation.

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In our first communication[1] on this subject we did not consider the effect of changing shape of the distribution of the neural impulse-rate, r, with consequent change in variance, as the photic intensity, I, decreases. We have, however, considered this in later papers[2,3]. Marriott's prediction from our original formulation that ΔI would become negative for stimulus conditions giving a sufficiently small percentage of positive responses depends on the distribution being normal. It is quite clear, however, that the distribution must change at low intensities, for a negative pulse-rate is impossible, and so it must become asymmetrical for low values of r. Now when we consider threshold conditions for various areas of stimulation, the pulse-rate for a given fibre must rise as the area, A, is reduced, if the threshold is to be maintained. But since fewer fibres are stimulated, the *total* number of impulses in unit time might not rise. We are inclined to think that for human central vision, at least, detection is based on the *average* pulse-rate. One of our reasons for holding this view is that in detecting a signal, ΔI, against a background, I, increases in the area of the background produce a lower threshold for discriminating the ΔI field[4]. It should be noted that this result does not hold for short flashes of ΔI. In this case (and most threshold determinations are made using short flashes) the background area has no effect, suggesting that the discrimination for short flashes of the signal, as opposed to continuous viewing, is a matter of detecting changes over time rather than over space. The experimental finding, that increase in background area, for continuous viewing, produces a reduction in the signal intensity (ΔI) required, suggests to us that no mechanism such as retinal facilitation will account for areal summation. It looks as though perception involves selecting relevant areas in the stimulus field. For example, if a narrow black ring is added to the background in the differential threshold situation, so that the signal lies at its centre, the threshold rises, and is the same as though the part of the background lying outside the ring were not there[4,5].

A further reason for thinking that average pulse-rates are used is that, for intensities well above absolute threshold, a larger area does not appear brighter than a smaller one of the same intensity, as would be expected if the total pulse-rate were being used as criterion. It is also the case that objects do not appear brighter when viewed with both eyes rather than one, though the threshold falls.

Although we would defend our general approach, there is the difficulty, pointed out by Dr. Marriott, that the threshold should not change when it is determined by 50 per cent positive responses. We do not ourselves know what the result for thresholds defined by 50 per cent or fewer correct responses would be, using the frequency-of-seeing method. Other methods produce a positive bias at low intensities, because there are fewer possible readings below the 50 per cent point than above it. Published frequency-of-seeing curves relate to flashes and do not give the information required.

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FORTHCOMING EVENTS

Wednesday, May 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Planet Venus and Its Atmosphere".

Thursday, May 29

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Group Captain W. K. Stewart: "The Institute of Aviation Medicine".

Friday, May 30

UNIVERSITY OF LONDON (in the Physiology Lecture Theatre, Guy's Hospital Medical School, St. Thomas's Street, London Bridge, London, S.E.1), at 5 p.m.—Dr. Hugh B. Cott: "Protective Coloration in Animals" (Fison Memorial Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

READER IN APPLIED MATHEMATICS—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (May 30).

SCIENTIFIC OFFICER (with a good honours degree in zoology, some research experience in invertebrate physiology and an interest in ecology) AT MERLEWOOD RESEARCH STATION, Grange-over-Sands, Lancashire, to join a team studying fauna of woodland soils—The Nature Conservancy (E), 19 Belgrave Square, London, S.W.1 (May 30).

ASSISTANT LECTURER (with a good degree or equivalent qualification, and preferably with industrial, research and/or teaching experience) AT THE TECHNICAL COLLEGE OF MONMOUTHSHIRE, Crumlin, to teach Chemistry and to specialize in Organic Chemistry to Ordinary National Certificate standard—The Director of Education, County Hall, Newport, Mon. (May 31).

ASSISTANT LECTURER (with a good degree or equivalent qualification, and preferably with industrial, research and/or teaching experience) AT THE TECHNICAL COLLEGE OF MONMOUTHSHIRE, Crumlin, to teach Physics with some Mathematics to Ordinary National Certificate standard—The Director of Education, County Hall, Newport, Mon. (May 31).

RESEARCH ASSISTANT (with a first- or second-class honours degree in geology) IN THE DEPARTMENT OF GEOLOGY—The Clerk to the Governors, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (May 31).

SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry), for work on research, development and analytical control in a wide field—The Medical Officer of Health (PH/D.1/A), County Hall, London, S.E.1 (May 31).

TECHNICIAN (preferably with experience in workshop practice or in histological techniques) AT THE MARINE BIOLOGY STATION—The Registrar, University College of North Wales, Bangor, North Wales (June 2).

ASSISTANT, Grade B (qualified to teach physics), IN THE SCIENCE DEPARTMENT, Croydon Technical College, Fairfield, Croydon—Chief Education Officer, Education Office, Katharine Street, Croydon, Surrey (June 4).

SCIENTIFIC OFFICER (male, with an honours degree in agricultural chemistry or chemistry, and preferably some knowledge of geology) IN THE CHEMICAL RESEARCH DIVISION of the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast, Northern Ireland (June 4).

ASSISTANT IN GEOLOGY—The Secretary of University Court, The University, Glasgow (June 7).

ASSISTANT LECTURER (preferably with some experience of structural analysis of organic and biomolecular compounds, and of the use of electronic digital machines) IN PHYSICS, with special reference to X-Ray Crystallography—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (June 7).

ASSISTANT LECTURER (with special qualifications in horticulture) IN BOTANY—The Registrar, The University, Manchester 13 (June 7).

DIRECTOR (of high academic standing in a branch of poultry science) OF POULTRY HUSBANDRY, University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 9).

SENIOR FELLOW IN THE DEPARTMENT OF EXPERIMENTAL PATHOLOGY, John Curtin School of Medical Research (Australian National University), Canberra—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 9).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 15).

PLANT PHYSIOLOGIST, an ASSISTANT SYLVICULTURIST, and an ASSISTANT ENTOMOLOGIST IN THE WATTLE RESEARCH INSTITUTE of the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 20).

SENIOR LECTURER IN PHYSICS (Durban); a SENIOR LECTURER IN PHYSICS (Pietermaritzburg); a LECTURER IN PHYSICS (Durban); and a LECTURER IN PHYSICS (Pietermaritzburg) (University of Natal)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 20).

LECTURER/SENIOR LECTURER (preferably able to teach and develop research in mycology) IN BOTANY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 28).

ASSISTANT PROFESSOR IN THE DEPARTMENT OF PHYSICS, Memorial University of Newfoundland, St. John's, Newfoundland, Canada—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Canada, June 30).

CHAIR OF MATHEMATICS (PURE AND/OR APPLIED) (Durban or Pietermaritzburg); and CHAIR OF EXPERIMENTAL PHYSICS (Durban) (University of Natal)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, June 30).

DEMONSTRATOR (ASSISTANT LECTURER) IN PHYSIOLOGY—The Registrar, The University, Leeds 2 (June 30).

LECTURER IN GEOLOGY at the University of Melbourne, Australia, chiefly to develop teaching in geomorphology and geological cartography, including photogeology and methods of geological and physiographical mapping in the field—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 30).

SENIOR LECTURER or LECTURER IN PHYSIOLOGY at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (June 30).

VETERINARY SURGEON, for the investigation of health and fertility problems in farm animals—The Secretary, Animal Research Organization, 6 South Oswald Road, Edinburgh 9 (June 30).

LECTURER IN THE DEPARTMENT OF PHYSICS, Victoria University of Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, July 15).

ASSISTANT LECTURER (Grade B) IN PHYSICS—The Principal, Peel Park Technical College, Salford.

ASSISTANT PROFESSOR (preferably with a higher degree and experience in the power field) OF ELECTRICAL ENGINEERING—The Dean of Engineering, University of New Brunswick, Fredericton, N.B., Canada.

HEALTH PHYSICISTS (with at least G.C.E. ("A"); H.N.C.; or equivalent, and plenty of tact) in the section assessing and controlling radiation and contamination hazards in reactor buildings and other "active" areas—Group Recruitment Officer (1110/34), Atomic Energy Research Establishment, Harwell, Didcot, Berks.

INSTRUCTOR, ASSISTANT PROFESSOR or LECTURER (with the degree of Ph.D. or equivalent research experience) IN PHYSICS—The Chairman, Department of Physics, Western Reserve University, Cleveland 6, Ohio, U.S.A.

JEVES' RESEARCH FELLOWS (2) (suitably qualified graduates or intending graduates) IN THE BIOLOGY DEPARTMENT, for research on (*a*) biological, and (*b*) physico/chemical aspects of chemical soil sterilization—The Registrar, University College of North Staffordshire, Keele, Staffs.

LABORATORY ASSISTANT TO WORK IN THE RADIOISOTOPE LABORATORY, Radiation Protection Service and X-Ray and Radium Section of a progressive Physics Department—The Secretary, Hammersmith Hospital, Du Cane Road, London, W.12.

LECTURER IN GEOLOGY AND GEOGRAPHY—The Warden, Goldsmiths' College (University of London), New Cross, London, S.E.14.

MASTER TO TEACH CHEMISTRY to advanced and, if possible, scholarship level—The Headmaster, Merchant Taylors' School, Crosby, Liverpool 23.

POSTDOCTORATE FELLOW IN THE DEPARTMENT OF CHEMISTRY, for work in the field of enzyme kinetics, with particular reference to chymotrypsin and cholinesterase—Prof. K. J. Laidler, Department of Chemistry, University of Ottawa, Ottawa 2, Canada.

RESEARCH ASSISTANT (student graduating this summer) IN INORGANIC CHEMISTRY with particular reference to Co-ordination Chemistry—Head of the Department of Science, Hatfield Technical College, Hatfield.

RESEARCH ASSISTANTS (honours graduates in physics), for work on problems concerned with fast particle techniques, gas discharges, spectroscopy and electronics—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

RESEARCH ASSISTANTS (2) (physical or inorganic chemists, with an honours degree and preferably two years research experience) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Exeter.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Wellcome Museum of Medical Science. Pp. 40. (London: The Wellcome Foundation Limited, 1958.) [4s

Palæontology, Vol. 1, Part 1 (November, 1957.) Pp. 86+14 plates. Published half-yearly. (London: The Palæontological Association, 1957.) 35*s*.; 5.20 dollars each part. [4s

Murphy Chemical Company, Ltd. How You Can Increase Profits by Pre-emergence Weedkilling. Pp. 4. The Control of Red Spider in Glasshouses with Kelthane Emulsion. Pp. 2. How you Can Protect Crops Safely with a New DDT Product. Pp. 6. Murphy Fruit Growers' Booklet, 1958. Pp. 108. How You Can Increase Crop Yields by Using Seed Dressings. Pp. 6. (Wheathampstead: The Murphy Chemical Co., Ltd., 1958.) [4s

British Hat and Allied Feltmakers Research Association. Tenth Annual Report of the Director of Research for the year ended August, 1957. Pp. 23. (Manchester: British Hat and Allied Feltmakers Research Association, 1958.) [4s

Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organization. Reference to Scientific Literature on Fire, Part 8, 1954. By Miss E. M. Shakeshaft and Mrs. B. F. W. Rogowski. Pp. 126. (Library Bibliography No. 5/Part 8.) (Boreham Wood, Herts: Fire Research Station, 1958.) [4s

The Carnegie Trust for the Universities of Scotland. Fifty-sixth Annual Report (for the year 1956–57) submitted by the Executive

Committee to the Trustees on 24th February 1958. Pp. iv+73. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1958.) [43

Library Association. Special Subject List No. 24: The Channel Tunnel. Pp. 11. (London: The Library Association, 1958.) 2s. 6d. [43

Some Modern Trends in Organic Chemistry. By Prof. D. H. R. Barton. (Inaugural Lecture delivered 3 December, 1957.) Pp. 35. (London: Imperial College of Science and Technology, 1958. Distributed by The Modern Book Co., Ltd., 19 Praed Street, W.2.) 2s. [43

Leadership in Scientific Research. By Sir Charles Harington. (Sir David Russell Memorial Lecture, No. 1, delivered before the University of St. Andrews, 12 November 1957.) Pp. 27. (London: Oxford University Press, 1957.) 3s. 6d. [43

International Tin Research Council. Publication No. 274: Annual Report, 1957. Pp. 36. (Greenford, Mddx.: Tin Research Institute, 1958.) [34

Freshwater Biological Association. Scientific Publication No. 5: A Key to the British Species of Freshwater Cladocera, with Notes on their Ecology. By the late D. J. Scourfield and Dr. J. P. Harding. Second edition. Pp. 55. 4s. 6d. Scientific Publication No. 17: A Key to the Adults and Nymphs of the British Stoneflies (Plecoptera), with Notes on their Ecology and Distribution. By Dr. H. B. N. Hynes. Pp. 76. (Ambleside: Freshwater Biological Association, 1958.) [43

The Registrar General's Decennial Supplement, England and Wales, 1951, Occupational Mortality, Part 2. Vol. 1: Commentary. Pp. xii+17. Vol. 2: Tables. Pp. ix+431. (London: H.M. Stationery Office, 1958.) £7 7s. 0d. net the two volumes. [43

The Manchester Museum. Report of the Committee for the year ending July 31st, 1957. Pp. 20. (Manchester: The University, 1958.) [63

Flora of Tropical East Africa. Edited by Dr. W. B. Turrill and E. Milne-Redhead. Gymnospermae. Pp. 16. (London: Crown Agents for Oversea Governments and Administrations, 1958.) 2s. [63

Mental Health Research Fund. Annual Report 1957, and Balance Sheet as at 30th September, 1957, with Income and Expenditure Account for the year to that date. Pp. 16. (London: Mental Health Research Fund, 1958.) [63

The Year Book of the Royal Society of London, 1958. (No. 62.) Pp. 367. (London: The Royal Society, 1958.) 21s. [63

Ministry of Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for 1956. East Midland Division. By W. B. Brown. Pp. ii+34+4 plates. (London: H.M. Stationery Office, 1958.) 3s. net. [63

National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1956 to 30th June, 1957. Pp. 30. (London: H.M. Stationery Office, 1958.) 2s. net. [63

Commonwealth Telecommunications Board. Sixth General Report, 1st January, 1956 to 31st December, 1956, and Statement of Accounts, 1st April, 1955, to 31st March, 1956. Pp. 56. (London: Commonwealth Telecommunications Board, 1958.) [103

The Heating and Ventilating Research Council. Second Annual Report and Statement of Accounts, 1957. Pp. 17. (Leatherhead: Heating and Ventilating Research Council, 1958.) [123

The British Hydromechanics Research Association. Tenth Annual Report, October 1956, to September 1957. Pp. 32. (Harlow: British Hydromechanics Research Association, 1958.) [123

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South Australia. Report of the Museum Board, 1st July, 1956 to 30th June, 1957. Pp. 14. (Adelaide: Government Printer, 1957.) [43

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi. Livraison 6: Yangami. Planchette 4: Yambaw A et B. Notice explicative de la Carte des Sols et de la Vegetation. Par A. Van Wambeke et L. Liben. Pp. 47. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1957.) 100 francs. [43

Smithsonian Institution. Proceedings of the United States National Museum. Vol. 107, No. 3385: The Foraminiferal Genus *Halyphysema* and Two New Tropical Pacific Species. By Alfred R. Loeblich, Jr. Pp. 123–126. Vol. 107, No. 3388: Studies of Seven Siderites. By Edward P. Henderson and Stuart H. Perry. Pp. ii+339–404+22 plates. (Washington, D.C.: Smithsonian Institution, 1958.) [43

Smithsonian Miscellaneous Collections. Vol. 135, No. 3: Geology of Barro Colorado Island, Canal Zone. By W. P. Woodring. Pp. iv+39+3 plates. (Publication 4304.) (Washington, D.C.: Smithsonian Institution, 1958.) [43

Smithsonian Institution: Bureau of American Ethnology. Bulletin 166: River Basin Survey Papers, No. 8: Excavations on the McNary Reservoir Basin near Umatilla, Oregon. By Douglas Osborne. With appendixes by Marshal T. Newman, Arthur Woodward, W. J. Kroll and B. H. McLeod. Pp. ix+288+40 plates. (Washington, D.C.: Government Printing Office, 1957.) 1.75 dollars. [43

University of California Publications in Botany. Vol. 29, No. 4: Secondary Phloem of Calycanthaceae. By Vernon I. Cheadle and Katherine Esau. Pp. 397–510+plates 60–67. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1958.) 2.25 dollars. [43

United States Department of Agriculture. Technical Bulletin No. 1175: History and Status of the Green Peach Aphid as a Pest of Tobacco in the United States. By F. S. Chamberlain. Pp. ii+12. (Washington, D.C.: Government Printing Office, 1958.) 10 cents. [43

Anales de Farmacia Hospitalaria, Ano 1, Nr. 1 (Diciembre, 1957.) Pp. 66. (Madrid: Servicos Farmaceuticos de la Excma. Diputacion Provincial de Madrid, 1957.) [43

Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff *Meteor*, 1925–1927. Herausgegeben im Auftrage der Deutschen Forschungsgemeinschaft von A. Defant. Band 16, Erster Teil: Ergebnisse der Aerologischen Beobachtungen. Die Höhenwinde über dem Tropischen und Südlichen Atlantischen Ozean (Messungen der Deutschen Seewatre bis 1939 Eingeschlossen.) Erste Lieferung, Abschnitt A: Allgeneine Statistiche Bearbeitung der Höhenwindmessungen. Von Erich Kuhlbrodt. Pp. 91. (Berlin: Walter de Gruyter und Co., 1958.) 37.50 D.M. [43

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Yale Peabody Museum of Natural History. Postilla. No. 32 (June 20, 1957): Additional Notes on the Horned Coot, *Fulica cornuta* Bonaparte. By S. Dillon Ripley. Pp. 2. No. 33 (November 1, 1957): On a New Species of *Anisops* (Hemiptera, Notonectidae) from the Moluccas. By G. E. Hutchinson. Pp. 4. (New Haven, Conn.: Yale Peabody Museum of Natural History, 1957.) [63

United States Department of the Interior: Geological Survey. Bulletin 1030-N: Geology and Uranium Deposits of the Caribou Area, Boulder County, Colorado. By F. B. Morre, W. S. Cavender, and E. P. Kaiser. Pp. iv+517–552+plates 35–40. 1.25 dollars. Bulletin 1051: Geology and Coal Resources of the Starkville-Weston Area, Las Animas County, Colorado. By Gordon H. Woods, Jr., Ross B. Johnson, and George H. Dixon. Pp. v+68+10 plates. n.p. Bulletin 1052-A: Scattered Gamma Rays from Thick Uranium Sources. By B. Y. Sakakura. Pp. vi+50. 25 cents. Bulletin 1066-C: Geophysical Abstracts 170, July–September, 1957. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselewsky and others. Pp. iii+191–282. 35 cents. Professional Paper 260-T: Chemical Erosion of Beach Rock and Exposed Reef Rock, Bikini and nearby Atolls, Marshall Islands. By Roger Revelle and K. O. Emery. Pp. iii+699–710+plates 225–229. 65 cents. Professional Paper 294-B: Studies of Longitudinal Stream Profiles in Virginia and Maryland. By John T. Hack. Pp. iv+45–98+plates 9 and 10. 75 cents. Professional Paper 294-D: Stromatolites of the Belt Series in Glacier National Park and Vicinity, Montana. By Richard Rezak. Pp. iii+127–154+plates 19–24. n.p. Professional Paper 294-F: Foraminifera from Carter Creek, Northeastern Alaska. By Ruth Todd. Pp. iii+223–236+plates 28 and 29. n.p. Professional Paper 294-G: Miocene Arthropoda from the Mojave Desert, California. By Allison R. Palmer. Pp. ii+237–280+plates 30–34. 1 dollar. Professional Paper 294-H: The Lower Ordovician Gastropod *Ceratopea*. By Ellis L. Yochelson and Josiah Bridge. Pp. iii+281–304+plates 35–38. 75 cents. Professional Paper 297-A: Geology and Beryl Deposits of the Peerless Pegmatite, Pennington County, South Dakota. By Douglas M. Sheridan, Hal G. Stephens, Mortimer H. Staatz and James J. Norton. Pp. iii+47+7 plates. 1.50 dollars. (Washington, D.C.: Government Printing Office, 1957.) [63

Journal of the Malacological Society of Australia, No. 1 (September, 1957). Pp. 52. (Melbourne: The Malacological Society of Australia, 1957.) 15s. [73

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Rapport Annuel pour l'Exercise 1956. Pp. 548. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1958.) 160 Belgian francs. [73

Fisheries Research Board of Canada. Bulletin No. 114: Salmon Research and Hydro-Electric Power Development. By J. R. Brett. Pp. vii+26. (Ottawa: Queen's Printer, 1957). 50 cents. [123

Federation of Malaya. Report on Forest Administration for the year 1956. Pp. iv+103. (Kuala Lumpur: Government Printer, 1957.) 2.50 Malayan dollars. [123

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East Africa High Commission. East African Virus Research Institute Report, July 1956–June 1957. Pp. iv+61. (Nairobi: Government Printer, 1957.) Sh. 5. [143

East African Meteorological Department. Memoirs, Vol. 2, No. 11: The Use of Cetyl Alcohol in Solution to Reduce Evaporation from Reservoirs—Report on an Experiment on Malya Reservoir in Tanganyika Territory, in August, 1957. By F. Grundy. Pp. ii+11. (Nairobi: East African Meteorological Department, 1958.) Sh. 4. [143

Colony of Mauritius. Meteorological Observations and Climatological Summaries, 1953. Part 7, July 1953. Pp. 12. Part 8, August 1953. Pp. 11. Part 9, September 1953. Pp. 11. Part 10, October 1953. Pp. 11. Part 11, November 1953. Pp. 12. Part 12, December 1953. Pp. 13. (Port-Louis: Government Printer, 1958.) [143

A List of Zoological and Botanical Types preserved in Collections in Southern and East Africa. Vol. 1: Zoology, Part 1. Pp. v+147. (Pretoria: South African Museums' Association, 1958. Obtainable from the Director, Transvaal Museum, Pretoria.) 7s. 6d. [173

Government of India: Ministry of Health. Annual Report of the Central Drugs Laboratory from April, 1954 to March, 1955. Pp. i+72. (Delhi: Manager of Publications, 1957.) Rs. 3; 5s. [173

Union of South Africa: Department of Commerce and Industries Division of Fisheries. Investigational Report No. 30: The South African Pilchard (*Sardinops ocellata*). Preliminary Report on Feeding Off the West Coast, 1953–56. By Dr. D. H. Davies. Pp. 40. (Reprint from *Commerce and Industry*, November, 1957.) (Pretoria: Government Printer, 1957.) [173

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Applications are invited for the Corbet and Henry Woodall Scholarship in Gas Engineering, tenable in the University, of the value of £135 a year. It is tenable for three years, with power of extension for a fourth year. The Scholarship is intended to enable a student to take a course of study in Gas Engineering at the University in preparation for a responsible position as a gas engineer. Applicants must be qualified to enter upon a degree course.

Further particulars and forms of application may be obtained from the Registrar, the University, Leeds, 2, to whom application should be made before June 30, 1958.

UNIVERSITY OF LEEDS

GAS PLANT MANUFACTURERS' DEVELOPMENT COUNCIL SCHOLARSHIP

Applications are invited for the above Scholarship of a value of £350 a year. The Scholarship is provided to enable promising students to follow an honours course in either Gas Engineering or Chemical Engineering as preliminary training for entry into the Gas Plant Industry. The Scholarship is open to applicants of British nationality from school or from industry; among the latter preference will be given to candidates already engaged in the Gas Plant Industry.

Applicants should reach the Registrar, the University, Leeds, 2, from whom further particulars and forms of application may be obtained, not later than June 30, 1958.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

POST-DOCTORAL GRANTS

Applications are invited for post-doctoral grants for research under the general direction of Professor R. N. Haszeldine, on each of the following topics: (1) The physical chemistry (kinetics) or organic chemistry (synthesis) of silicones and polysiloxanes. (2) The organic chemistry of compounds containing sulphur and fluorine. The value of each grant will be £850 per annum.

Applications, including the names of three referees, should be addressed to the Registrar, the Manchester College of Science and Technology, Manchester 1, by May 31, 1958.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

The Council of the College invites applications for a Scholarship established by British Industrial Plastics Ltd., for the encouragement of research into the application of plastics to paper. The holder will work under the direction of the Head of the Department of Textile Chemistry. Candidates should have a good honours degree in chemistry. The value of the Scholarship will be £400 per annum and the holder will be expected to work for a higher degree.

Particulars of the regulations appertaining to the Scholarship may be obtained from the Registrar, the Manchester College of Science and Technology, Manchester, 1, to whom applications should be returned by May 31, 1958.

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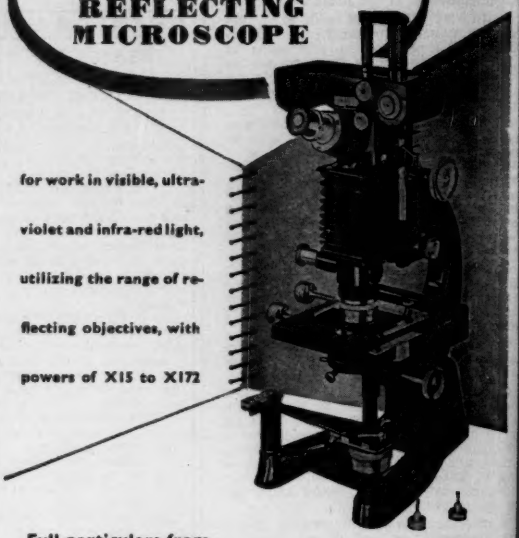

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